RTLAB: A REACTION-TIME LABORATORY FOR THE DATA GENERAL NOVA MINICOMPUTER

by

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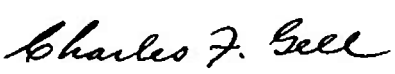

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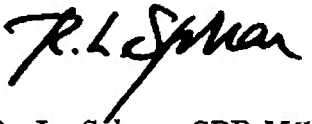

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SUMMARY PAGE

THE PROBLEM

To prepare a general purpose package of assembly language subroutines for the on-line design, control, and analysis of behavioral experiments.

FINDINGS

The details of the organization and use of RTLAB, a package of relocatable assembly language subroutines for the Data General NOVA family of minicomputers, is presented, and sufficient program documentation is provided to allow users to modify subroutines, as needed.

APPLICATION

RTLAB should be of use to any investigator using a NOVA minicomputer system for on-line data acquisition in discrete-trial behavioral experiments.

ADMINISTRATIVE INFORMATION

This investigation was conducted as part of Bureau of Medicine and Surgery Research Unit MF51.524.004-2002DX5G. The present report is Number 5 on this work unit. It was submitted for review on 19 July 1973, approved for publication on 7 August 1973, and designated as NavSubMedRschLab Report No. 748.

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ABSTRACT

RTLAB is a package of relocatable assembly-language subroutines for the design, control, and analysis of behavioral experiments on the Data General Corporation NOVA family of computers. It was originally designed for use in reaction time research but is readily adaptable to any discrete-trial task. RTLAB accepts design parameters from the experimenter for a given experiment and then produces an appropriately randomized and counterbalanced set of trials for presentation to a subject. During an experimental session RTLAB controls the presentation of stimuli, the acceptance and scoring of responses, and all of the timing and input-output constraints associated with control and data acquisition. Its current design does not allow for time-sharing among more than one subject station. A history of the experiment is saved for later analysis and transfer to storage media. User modifications of any of the details of these operations is facilitated by the organization of RTLAB into subroutine modules. The organization of RTLAB and its use are presented, along with sufficient documentation of the routines to allow user modification where appropriate.

RTLAB: A Reaction-time Laboratory for the Data General NOVA Minicomputer

INTRODUCTION

Reaction time is one of the most basic empirical measures available to the experimental psychologist, and has never been more popular than it is today. Increased interest in reaction time paradigms has coincided with growing availability of inexpensive minicomputer systems that are ideally suited for the on-line control of such experiments. The present report describes the general organization and use of one such on-line reaction-time laboratory developed in the Human Factors Branch of the Submarine Medical Research Laboratory on a Data General Corporation NOVA 1220 minicomputer. This set of routines, called RTLAB, is a complete research package, allowing the investigator to design and run experiments and analyze data in most reaction time paradigms. RTLAB is of course totally compatible with any of the Data General Corporation family of minicomputers, requiring only minor modifications to mate it with the user's specific configuration of I/O devices. RTLAB could probably be adapted to other 16-bit machines with little difficulty, and its general logic could be used for setting up a similar set of routines on any other on-line laboratory system.

OVERVIEW

RTLAB does the following tasks. Upon entry (assuming it is being used for the first time) it queries the user for a number of design parameters. These are saved so that subsequent runs of the same experiment do not require re-entering these parameters. It then asks for a subject number and some other information specific to the running of a given sequence of trials. Once all general and specific parameters are entered RTLAB sets up a randomized and counterbalanced sequence of trials for the current experimental session and halts, awaiting the experimenter's command to start the experimental sequence. When this sequence is started RTLAB controls the timing and presentation of stimuli from trial to trial, records responses and reaction times, provides feedback for the subject, and stores all data for later analysis and output. Once the experimental sequence is over the program again halts, providing messages to the experimenter and to the subject. The experimenter then has several options: (a) do a brief analysis of the data on the spot, obtaining overall means and means broken down by correct-incorrect, stimuli, foreperiods, and, if desired, blocks of trials; (b) list the trial-by-trial data on the teletype; (c) write the trial-by-trial data on magnetic tape for off-line analysis on a large computer. Option (c), in the version of RTLAB presented here, was dictated by our own hardware constraints and typical uses, and could be altered by another user to allow data storage on disk, paper tape, or some other appropriate medium. At the completion of the analysis and listing options exercised by the user,

control returns to the beginning of RTLAB. By entering the same experiment identification number the user can run another subject in the same design, with RTLAB automatically providing a new counterbalanced, randomized sequence of trials. Or, if the computer will be used for other purposes before another subject will be run, the user can punch RTLAB or the parameter addresses (for use as an overlay) on paper tape for later use. Finally, by entering a new experiment identification number the user can alter the design in any way he desires.

RTLAB is designed to be maximally adaptable by a user. The program is organized into subroutine modules which can be altered, or exchanged, using the NOVA extended assembler software options for independent assembly of relocatable subprograms. Thus, for instance, if the user wanted to change the magnetic tape routines to match his own configuration, only subroutines MTAPE and EOF would have to be altered.

This modular organization is important in mating RTLAB with the user's input and output devices. The version of RTLAB presented as an example here used a Tektronix 4010 CRT display with keyboard for presenting stimuli and receiving the subject's responses. Other paradigms in our laboratory use the teletype to present and record, or go through a general purpose input-output interface to devices like slide-projectors, tachistoscopes, telegraph keys, and so forth. All meshing of RTLAB with this variety of possible devices is done via subroutine ALPHA and its associated routines. Thus, the user can write his own version of ALPHA, subject to constraints discussed later in this report, to merge RTLAB with his own hardware. This allows rapid and simple conversion of RTLAB, whose general logic is not dependent upon hardware considerations.

As presently written, all subroutines in RTLAB reside in core at the same time. The NOVA 1220 in our lab has 8K of core, and RTLAB occupies approximately 5-6K, depending upon the complexity of ALPHA (which varies with different experiments). A user with only 4K could store subroutines on magnetic tape, paper tape, or disk, and call them in as needed. RTLAB uses a real-time clock for all timing. The following peripherals are available in our laboratory: a KSR 33 teletype, a high speed paper tape punch-reader, a Tektronix 4010 CRT, and a Calma 650 write-only magnetic tape unit. For purposes of exposition the examples of program details and use in this report assume this set of peripherals.

RTLAB was designed as a general purpose on-line system for experiment design, control, and simple data management for virtually any possible reaction time experiment. In E. Smith's[1] terms, all paradigms he discusses except the one-many stimulus-response mapping arrangement are possible. (A one-many paradigm could be run if responses were coded cleverly in ALPHA. See detailed discussion of ALPHA later.) Further, RTLAB is presently designed for paradigms where each stimulus and each foreperiod will appear equally often in a sequence of trials. Although RTLAB is designed primarily for

reaction time paradigms, clearly it can be used without modification for any multiple-stimulus, single-response, discrete-trial learning or problem-solving task where correctness of response or latency of response is a dependent variable. Examples of other tasks particularly well-suited to RTLAB would include continuous paired-associate learning, continuous recognition learning, concept identification, discrimination learning, probability learning, and signal detection. Relatively minor modifications in software would allow the use of RTLAB's basic logic in virtually any discrete-trial experimental paradigm.

The remainder of this report will present details of the overall structure of RTLAB and its use. For simplicity of exposition, we will describe RTLAB in the context of a particular implementation in our own laboratory, namely, the design of Experiment I reported by Olson and Laxar.[2] But the potential user should keep in mind the wide range of possible uses for RTLAB. Except for several flow charts of main subroutines and a complete assembler listing of all subroutines in RTLAB in the final section of this report, the description of RTLAB will be from the perspective of a user rather than that of a programmer. The single important exception is the discussion of ALPHA, the routine through which each user must mate his own particular experimental setup with RTLAB.

DESIGN CONSTRAINTS

The user has a number of options available in setting up experiments to be run with RTLAB. The program asks for the experimenter's specifications through a series of simple queries on the teletype (see the section on program use for the format of these queries). The following paragraphs discuss the options available and describe the current software constraints on the values of experimental parameters. All values discussed are decimal, and those whose limits are not explicitly mentioned are constrained by the NOVA 16-bit single precision arithmetic (maximum value = 65565). It is especially important that the user pay attention to the constraints discussed in paragraph E.

A. Number of trials. The present version allows up to 256 trials. A user with adequate core storage could change this limit by increasing the arrays addressed at STIM, FORE, PLACE, and SPACE in subroutine DESIGN and at CODE and TIME in subroutine SCORE.

B. Foreperiods. Up to 16 different foreperiod values can be specified. Entries are in milliseconds.

C. Stimuli. Up to 64 different stimuli can be specified. The user enters the stimuli as digital codes whose meaning is contained in subroutine ALPHA or one of its associated subroutines. See the examples in the section on program use.

D. Stimulus-response mappings. The user specifies one correct response code for each stimulus code he enters. Again, this correct response code is assumed to have an interpretation in ALPHA. Any one-one

or many-one configuration of stimuli and correct response codes is acceptable.

E. Blocking for randomization. RTLAB contains routines which, given specifications about stimuli, foreperiods, and number of trials, set up a randomized, counterbalanced sequence of trials for presentation to a subject. These routines operate upon a block of n contiguous trials, producing a single random permutation of the n trials. Within a block each combination of stimulus and foreperiod must appear equally often. Thus, the minimum block size for purposes of randomization is the product of the number of stimuli and the number of foreperiods. The general expression for block size is given in (1), where K is an integer greater than zero. The relationship between number of trials

$$(1) \quad B = K\,(\#Stim)(\#FP)$$

(T) and block size (B) is given in (2), where N is an integer greater than zero.

$$(2) \quad T = N \times B$$

The constraints in (1) and (2) are very important, for if they are violated the sequence of trials presented to the subject will not have proper counterbalancing. Examples of acceptable and unacceptable combinations of number of trials, block size, number of stimuli and number of foreperiods are shown in Table 1. Since the user is responsible for guaranteeing that these constraints are met, a short message is printed on the teletype during the design query reminding the user of the nature of the constraints (see section on program use).

F. Inter-trial interval. In our research, this has referred to the time between the subject's response and the presentation of the signal that the computer is ready to present the next trial. The subject's acknowledgment of that signal initiates the foreperiod of the next trial. Figure 1 shows this sequence of events.

G. Minimum and maximum reaction times. The user must specify limits on the range of acceptable reaction times. The limits were incorporated in the program to detect lapses by the subject into random responding or inattention and to force the investigator to define the range of acceptable data before rather than after the fact. The range limit can be effectively bypassed by setting them very small and very large.

H. Rerun or discard errors. The user can decide either to rerun all errors or to run the fixed sequence of trials, retaining the error data for analysis or discarding it, as appropriate. When errors are rerun, they are all rerun at the end of the regular sequence in the order in which they were made. The current maximum on rerun trials is 128.

RUNNING THE EXPERIMENT

The user has great flexibility on how each trial will be run. The

Table 1. Examples of Valid and Invalid Combinations of Basic Parameters

No. Stimuli	No. Foreperiods	No. Trials	Block Size	Comment
4	1	112	28	Valid.
48	1	240	48	Valid.
2	2	96	8	Valid.
1	5	100	20	Valid.
16	2	64	64	Valid.
5	3	150	15	Valid.
4	2	112	4	Invalid. Block size does not equal foreperiods times stimuli.
4	1	100	10	Invalid. Block size does not equal an integral function of foreperiods times trials.
16	1	100	16	Invalid. Stimuli × Foreperiods (or block size) not integral in number of trials.
8	2	80	32	Invalid. Block size not integral in number of trials.

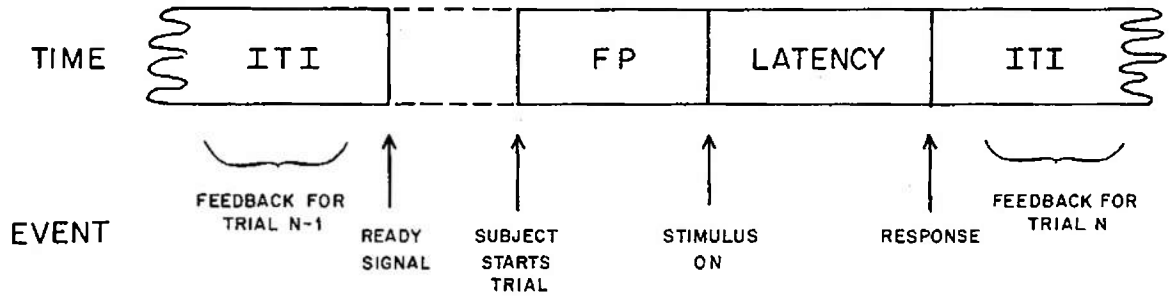

Fig. 1. Sequence of trial events for a subject-paced reaction time experiment.

definition of events in Figure 1 is merely an example from our own research. We use a self-paced task, where the subject initiates each trial after the ready signal. The foreperiod is the time from the subject's initiation of the trial to the presentation of the stimulus. The intertrial interval begins with the subject's response and ends with the presentation of the ready signal. This interval is constant regardless of the magnitude of the subject's reaction time.

RTLAB records two pieces of information on each trial, the subject's reaction time in milliseconds and a response code which indicates whether the subject was correct, incorrect, or violated a constraint on maximum time or minimum time. These are stored by subroutine SCORE, and along with the tables of trial-by-trial stimuli and foreperiods provide a complete record of the experimental events for later analysis and listing. (See details of SCORE and the storage of information in later sections.)

ANALYSIS AND LISTING OPTIONS

RTLAB provides some low-level data analysis for each subject via subroutine RTANL. It is assumed that any complex analysis and analyses across subjects will be done off-line. Users may want to tailor RTANL to their own needs.

The present version of RTANL provides the analysis shown in Table 2. The standard analysis includes mean reaction times for various logical partitions of the data, while the optional analysis allows for a further breakdown into blocks of contiguous trials. The size of these blocks does not have to correspond to the size of the blocks used in randomizing the experimental sequence. However, it is up to the user to create meaningful block sizes for the analysis. Examples of the output of the analysis routine are given in a later section.

RTLAB also allows the user to transfer the raw data to various storage media.

Table 2. Data Analyses Provided by RTANL for each Subject

Standard Analysis Includes --

1. Overall results
2. Analysis by stimuli (if more than one)
3. Analysis by foreperiods (if more than one)
4. Analysis by stimuli × foreperiods (if both more than one)

-- Mean reaction time and frequency counts are calculated for each of these for:

A. All data
B. Corrects alone
C. Errors alone

} Only if errors are possible

Optional analysis

All of the above repeated for blocks of trials, where block size is entered at the time of analysis (N.B. It is up to the user to create meaningful block sizes.).

The version of RTLAB in use at NAVSUBMEDRSCHLAB allows a listing of the raw data on the teletype and a transfer of the raw data to magnetic tape for analysis off-line on a large computer.

THE USE OF RTLAB

This section presents a step-by-step guide to the use of RTLAB. It will be assumed that the reader is familiar with the general description of RTLAB's structure and constraints presented in previous sections.

Table 3 lists the subroutines of RTLAB and their addresses obtained via the NOVA relocatable loader. This gives the user a rough idea of the size of the various routines. Table 4 is a list of the interprogram symbols and

Table 3. Program Elements and Addresses from Relocatable Loader

Starting Addresses		
Element Name	Normal	Page Zero
RTEXP	440	50
BETA	711	107
RTINT	1706	121
SCORE	2054	122
DESIG	3304	130
MTAPE	6724	220
EOF	7154	224
DATYP	7235	226
RANDI	7376	234
PERMU	7434	235
INOUT	7521	237
BMAN	7774	247
NZMEM	10024	250
CRTXT	10054	251
BOX	10107	252
ALS	10504	253
RTANL	10717	257
CARVE	12076	303
PROQ	12245	304
DPACC	12302	310
	12444	312

Table 4. Interprogram Symbols and Their Addresses from Relocatable Loader

Symbolic Addresses	Octal Addresses	Symbolic Addresses	Octal Addresses	Symbolic Addresses	Octal Addresses
ABEGI	ØØØ13Ø	ARTUP	ØØØ121	MAX	ØØØØ52
ABNDC	ØØØ237	ASCOR	ØØØ122	MCURS	ØØØ256
ABNOC	ØØØ243	ASTIM	ØØØ132	MIN	ØØØØ51
ACLER	ØØØ25Ø	ATIME	ØØØ124	MONK	ØØØ3Ø4
ACODE	ØØØ123	ATYPE	ØØØ166	NFP	ØØØØ6Ø
ACS	ØØØ14Ø	AWERB	ØØØ222	NOVER	ØØØØ63
ADAT	ØØØ232	BTXT	ØØØ226	NUN	ØØØ3Ø5
ADCBN	ØØØ24Ø	CHAR	ØØØ253	OLD	ØØØ236
ADONE	ØØØ112	CLEVE	ØØØ3Ø3	OVINC	ØØØ126
AEOF	ØØØ224	CLMSK	ØØØØ5Ø	PHALF	ØØØ12Ø
AFORE	ØØØ131	CRESP	ØØØØ62	PRES	ØØØ111
AFP	ØØØ137	CS	ØØØØ65	PSYCH	ØØØ257
AGETC	ØØØ242	CT	ØØØØ55	QUACC	ØØØ31Ø
ALGAE	ØØØ3Ø6	CTDWN	ØØØØ71	RCHAR	ØØØ254
AMAIN	ØØØ1Ø2	CTRLS	ØØØØ76	REPC	ØØØ127
AMOEB	ØØØ3Ø7	EXP	ØØØØ61	RESP	ØØØØ75
AOCBN	ØØØ244	FP	ØØØØ64	RLBOX	ØØØ252
AOUTP	ØØØ247	GROUP	ØØØØ56	RTIME	ØØØØ72
AOVER	ØØØ125	IDBIN	ØØØ246	SEC	ØØØØ66
APE	ØØØ167	IFORE	ØØØ133	SHOW	ØØØ251
APRMT	ØØØ235	IGETI	ØØØ245	SKTCH	ØØØ255
APUTC	ØØØ241	INTER	ØØØØ7Ø	SUBJ	ØØØØ57
ARAND	ØØØ234	ISTIM	ØØØ134	TRLS	ØØØØ54
ARAP	ØØØ1Ø1	ITI	ØØØØ53	TTIME	ØØØØ73
ARESP	ØØØ141	ITYP	ØØØ233	UQUER	ØØØ116

their absolute addresses for the example in Table 3.

The complete package specified in Table 3 would usually be loaded via an absolute binary tape. The tape would self-start at location MAIN (indirectly addressed by AMAIN), printing the heading shown at the top of Figure 2. As the teletype message reminds the user, all numeric entries are decimal and all times are in milliseconds. All numbers are entered in the same fashion: the string of decimal digits is followed by a carriage return (the familiar decimal-to-binary routine of Data General). The legality of input parameters is not checked. If a mistake is made the program must be restarted at location MAIN.

```
PT EXP PROGRAM
ALL ENTRIES ARE DECIMAL, ALL TIMES IN MSEC.

EXPERIMENT CODE = ? 123

NEW CODE.  CHANGE DESIGN? (1) NO (2) YES 2

BLOCK SIZE MUST EQUAL N(#STIM)(#FP), WHERE
N IS AN INTEGER > 0.  BLOCK SIZE MUST ALSO
BE AN INTEGRAL QUOTIENT OF # TRIALS.

NUMBER OF TRIALS = ? 48

BLOCK SIZE = ? 4

ITI = ? 2000

MAX RT = ? 1500

MIN RT = ? 120

NUMBER OF FOREPERIODS = ? 1

FOREPERIODS IN MSEC.
   1 1000


NUMBER OF STIMULI = ? 4

TYPE STIMULUS CODE FOLLOWED BY CORRECT RESPONSE CODE
   1     STIMULUS CODE =  4
         RESPONSE CODE =  1

   2     STIMULUS CODE =  3
         RESPONSE CODE =  2

   3     STIMULUS CODE =  2
         RESPONSE CODE =  2

   4     STIMULUS CODE =  1
         RESPONSE CODE =  1


REPIN ERRORS & NULLS (1) OR DISCARD (2)? 2

SUBJECT NUMBER = ?
```

Fig. 2. Sample teletype print-out for the entry of a new experimental design in RTLAB.

The program first requests an experiment number, as shown in Figure 2. If this identification number is already known to the program, it is assumed that all parameters were entered on a previous run. In the latter case, all queries between the dashed lines in Figure 2 are skipped and the program goes on to the queries, starting with subject number, that have to do with the specific run (see below).

Only the current experiment number is saved, so just one set of experimental parameters is present in memory at a given time. Thus, values can only be saved between contiguous runs of the same experiment by leaving them in the machine, by punching a complete tape of RTLAB, or by punching an overlay of locations containing the parameter values. The overlay would be read in after the complete RTLAB tape. Table 5 shows the memory locations needed for such an overlay.

Table 5. Memory Ranges for Overlay

Program Element	Symbolic Address
RTEXP	MIN to EXP
SCORE	REPC
DESIGN	FPTAB to RTAB+77_8

If the experiment number is a new one the teletype queries proceed as in Figure 2. The program acknowledges that the code is a new one, and double checks that the user does in fact want to change all the parameters. If the user responds "yes" with a numeric two, the program proceeds as in Figure 2. If the response is "no", the program asks, as shown in Figure 3, whether the user desires to change the

```
RT EXP PROGRAM
ALL ENTRIES ARE DECIMAL, ALL TIMES IN MSEC.

EXPERIMENT CODE = ? 301

NEW CODE.  CHANGE DESIGN? (1) NO (2) YES 1

CHANGE CODE? (1) NO (2) YES 2

SUBJECT NUMBER = ?
```

Fig. 3. Sample print-out for changing the experiment code without changing the design.

experiment code. If the user responds "yes" as in Figure 3 the code entered replaces the previous code but all previous parameter values are retained, the program jumping to the subject number query. If the user would have responded "no" to the query about changing the code RTLAB would have returned to the first question and asked for the experiment code again.

In Figure 2 once the program has learned that a set of design parameters is to be entered a short reminder about the randomization constraints described in a previous section is printed and a series of straightforward queries is made about each of the design parameters. Note that once the user specifies the number of foreperiods the program asks for the value of each. Similarly, after the number of stimuli has been specified the program asks for a numeric code for each stimulus and a similar code for the correct response associated with each stimulus. Recall that these numeric codes are given meaning in terms of system interfaces by the user-supplied subroutine ALPHA.

Each of the possible sequences of queries shown in Figures 2 and 3 ended with the query about the subject number. Figure 4 shows the continuation of the user-computer dialog which would hold for any of these cases. The subject number and group number are for identification. On the assumption that the combination of subject number and experiment number will be unique, these two are used to derive the seed for the pseudo-random number generator which controls the randomization of the sequence of trials. Thus, pairing the same subject number with the same experiment number will result in an identical sequence of trials, given constant experimental parameters.

The queries after group number are specific to a particular application of RTLAB and are part of subroutine ALPHA. All queries up to this point have come from subroutine DESIGN. Usually the user will need to know some additional details about the encoding of responses at the subject's station. In the example shown in Figure 4, the ASCII characters to serve as "true" and "false" responses on the CRT keyboard are required, since this was counterbalanced from subject to subject. Application-specific queries should be part of ALPHA and addressed from RTEXP via the instruction JSR@UQUER. If the user has no special queries, he must at least provide for a return back to RTEXP from ALPHA.

Once all parameters have been entered, RTLAB designs the complete set of trials to be run and halts, printing the teletype message shown at the bottom of Figure 4. As soon as the experimenter and the subject are ready to proceed, the former presses CONTINUE on the NOVA console and the experiment would be run. The details of the running of the experiment are controlled entirely by the user in subroutine ALPHA. A more complete discussion of the user-supplied routines that might compose ALPHA is supplied in the last section of this report on user-modifications. Basically, the main routine RTEXP counts down the number of trials and jumps on each trial to ALPHA via JSR @PRES. Prior to returning to RTEXP

```
SUBJECT NUMBER = ? 101

GROUP NUMBER = ? 1


"TRUE" CHARACTER = ? /

"FALSE" CHARACTER = ? Z

PRESS CONTINUE TO START SESSION.
```

Fig. 4. Sample print-out for entering subject-specific information.

from this jump the routines in ALPHA must take care of presenting the trial, monitoring the subject's performance on that trial, and storing the raw data in appropriate tables for later analysis or listing. In a very real sense, ALPHA is where the important work is done on each trial. After the last trial has been run RTEXP jumps to ALPHA via JSR@ADONE for a message or signal to the subject that the session is over. After pressing continue any teletype interrupt prior to the completion of the sequence of trials aborts the run. The experimenter can terminate a session, but it must be remembered that it will only be possible to restart the session at the beginning.

An example of the experiment entered in Figure 2 is now presented. The subject starts each trial by pushing any key on the CRT keyboard. One second later a display like that shown in Figure 5 would flash on the screen, and the subject would decide as quickly as possible whether the word in the center correctly named the side of the square on which the diamond appeared. As soon as the subject responded the display would disappear and information like that shown in Table 6 would appear as feedback. This feedback would remain on for two seconds (the intertrial interval) and as soon as the feedback disappeared the subject could start the next trial.

When control returns to RTEXP after the JSR@ADONE to ALPHA, the message shown at the top of Figure 6 is printed on the teletype and the program halts. The analysis routines are initiated by pressing CONTINUE on the console. A brief series of queries are made as shown in Figure 6. The output resulting from these choices is also shown in

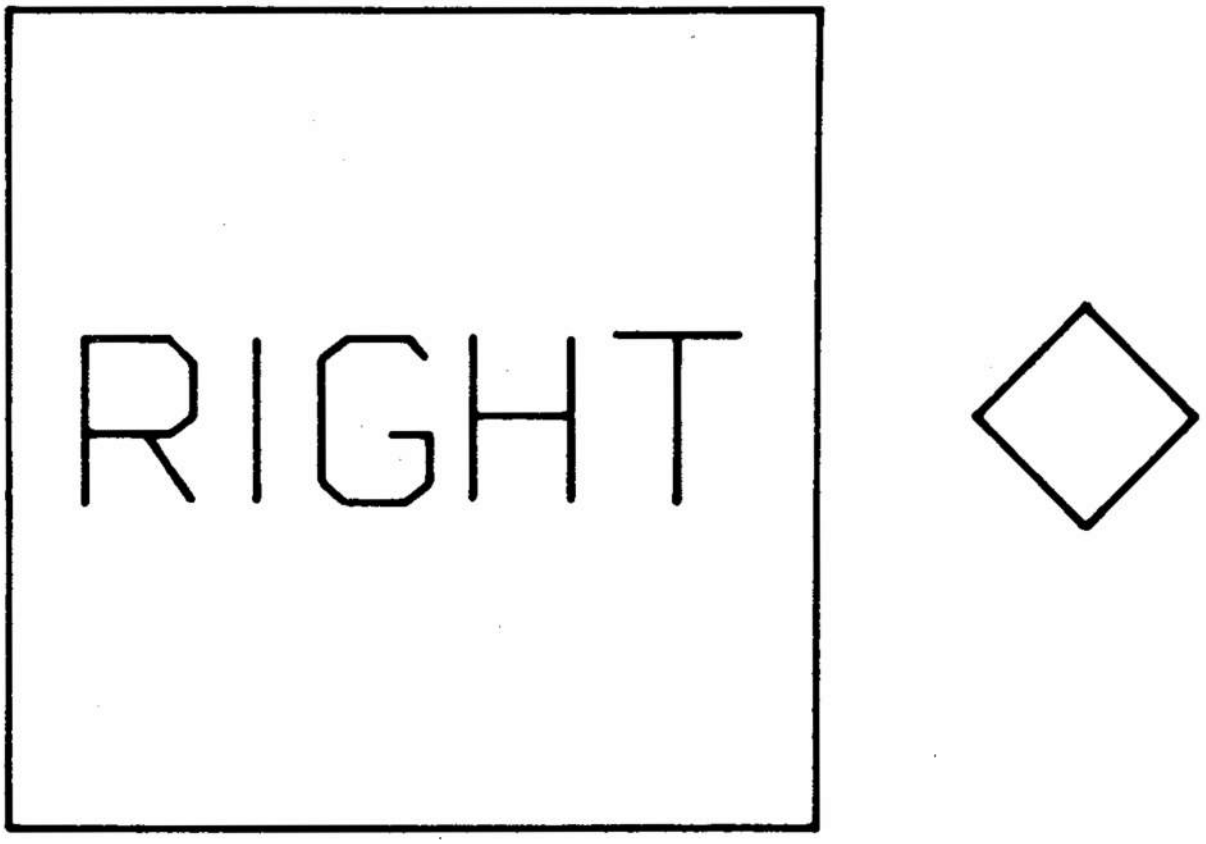

Fig. 5. Sample CRT display (based on Olson and Laxar, 1973).

Table 6. Feedback Messages to Subject from ALPHA via CRT

Event	Message
Correct response	TRUE TIME = 748 MILLISECONDS
Incorrect response	TRUE ERROR TIME = 1039 MILLISECONDS
Response not defined in program	ILLEGAL RESPONSE ERROR TIME = 683 MILLISECONDS
RT less than minimum allowed	FALSE TOO FAST
RT greater than maximum allowed	TOO SLOW
Trial sequence over	END OF SESSION. THANK YOU.

```
PPESS CONTINUE FOP ANALYSIS


 DATA ANALYSIS FOP PT EXPEPIMENT NO.    123
 SUBJECT NO.    101

 ANALYSIS BY BLOCKS? (1) YES (2) NO 2


TYPE OUT DATA? (1)NO OR (2)YES  2


OVEPALL ANALYSIS

   OVEPALL PT      N    COPPECT PT      N      EPPOP PT      N

     500.7708     48      501.1627     43      497.4000      5


ANALYSIS BY STIMULI

 STIM    OVEPALL PT      N    COPPECT PT      N      EPPOP PT      N

    1      369.5000     12      369.5000     12        0.0000      0
    2      543.7500     12      543.7500     12        0.0000      0
    3      576.7500     12      599.4545     11      327.0000      1
    4      513.0833     12      499.6250      8      540.0000      4

TPIAL   STIMULUS    F P      P T      CODE

    1        2      1000      373        1
    2        3      1000      570        1
    3        4      1000      501        1
    4        1      1000      290        1
    5        4      1000      507        1
    6        1      1000      329        1
    7        2      1000      524        1
    8        3      1000      522        1
    9        3      1000      889        1
   10        1      1000      481        1
   11        2      1000      639        1
   12        4      1000      482        1
   13        3      1000      491        1
   14        2      1000      502        1
   15        1      1000      382        1
   16        4      1000      419        1
```

Fig. 6. Sample print-out for on-line analysis following the completion of a single subject's session. (Part 1 of 2 parts)

17	4	1000	532	1
18	1	1000	303	1
19	2	1000	553	1
20	3	1000	808	1
21	1	1000	409	1
22	2	1000	632	1
23	3	1000	594	1
24	4	1000	421	1
25	4	1000	632	2
26	1	1000	485	1
27	2	1000	491	1
28	3	1000	611	1
29	3	1000	327	2
30	4	1000	443	2
31	1	1000	271	1
32	2	1000	519	1
33	4	1000	655	1
34	2	1000	562	1
35	1	1000	289	1
36	3	1000	609	1
37	1	1000	382	1
38	4	1000	480	1
39	2	1000	559	1
40	3	1000	402	1
41	1	1000	469	1
42	3	1000	533	1
43	4	1000	568	2
44	2	1000	654	1
45	2	1000	517	1
46	1	1000	344	1
47	3	1000	565	1
48	4	1000	517	2

MOUNT AND READY TAPE, PRESS CONTINUE.

Fig. 6. Sample print-out for on-line analysis following the completion of a single subject's session. (Part 2 of 2 parts)

Figure 6, and upon completion of the output the program again halts with a message about the magnetic tape, shown at the bottom of Figure 6. If one had asked for the analysis by blocks the analysis would have been repeated for each block. If one did not ask for a listing the entire listing would be suppressed. If errors had been rerun, no breakdown would be given for corrects and errors, but the number of trials rerun would be shown at the beginning of the analysis. One can suppress all the output by going to location MAIN when the program halts at the end of the session.

The magnetic tape output is straightforward. It can be bypassed by manually returning control to the beginning of RTLAB via the console switches. If a tape is written control automatically returns to the beginning of RTLAB after the end of file is written. Appendix A contains a schmatic of our tape format.

FLOW CHARTS AND SUBROUTINE LISTING

Appendix B contains a complete table of subroutines and their primary functions for the sample experiment described in this report. Appendix C has flow-charts for the most important subroutines, and can be used as a guide to the program listings. Appendix D contains these listings for all subroutines used in the sample experiment.

SUMMARY OF USER MODIFICATIONS

Required modifications. For most applications of RTLAB the user must write a subroutine ALPHA and any subroutines required by ALPHA. RTLAB is designed so that this should be the only detailed programming required by the user. If a user finds he has to extensively modify a significant number of other routines in RTLAB as well, then there may be little advantage to RTLAB over the writing of the experimental package from scratch. But the user must be prepared to write at least this one routine.

The main program RTEXP calls routines in ALPHA for three different purposes. Thus, ALPHA must include indirect entry points for the following calls from RTEXP: (a) UQUER for any user-specific design queries; (b) PRES for the presentation of each trial; and (c) ADONE for the termination of the experiment. (a) and (c) are relatively straightforward, and depend entirely upon the desires or needs of the user. If either or both of these functions are not needed, the user can effectively bypass the calls by inserting a JMP 0,3 at the appropriate address in ALPHA.

However, function (b) is central to the use of RTLAB and thus the requirements for a jump via PRES to ALPHA and the necessary communications with other subprograms in RTLAB must be spelled out in some detail. The jump via PRES must take care of all timing functions, must present stimuli and accept responses, must encode the responses and contrast these with stored tables of appropriate responses, and must store response information and latencies via subroutine SCORE. The stimulus code, correct response code, and foreperiod value for each

trial are passed by RTEXP to ALPHA via locations CS, CRESP, and FP. Those locations are defined in RTEXP and must be declared as displacement externals in ALPHA. Subroutine ALPHA must translate the stimulus code into some actual stimulus for presentation. For instance, the codes 1-4 shown in Figure 2 are used by the ALPHA in Appendix D to present one of four stimulus displays, like the sample shown in Figure 5, on the CRT screen. See the details in Appendix D, especially subroutine BOX, which is called by ALPHA for drawing the displays on the screen. Similarly, the ASCII code received from the CRT keyboard when the subject responds is translated into the appropriate response code for transmission to SCORE. In our example, the encoding of "true" and "false" which had been entered prior to the run (see Figure 4) is stored in locations TRUE and FALSE in ALPHA. The keyboard entry from the subject's response is first compared with these to recover the "true" or "false" response and then compared with the code in CRESP for classification as correct or incorrect.

The data on each trial are stored by means of JSR @ ASCOR to subroutine SCORE. The latency is passed via the address TTIME and the scored response code is passed via RESP. Both are defined in RTEXP and declared as displacement externals in ALPHA. The scoring of the response is done in ALPHA, with the following code passed to SCORE: 1 = correct, 2 = error, 3 = too fast, too slow. Subroutine SCORE obtains the trial count, CTRLS, from RTEXP. SCORE keeps track of which trials have to be rerun, and RTEXP contains the necessary programming to rerun these trials when the rerun option is used.

All timing is coordinated in ALPHA. The real-time clock is set initially by RTEXP to interrupt the program every millisecond when it is enabled, and the interrupt service routine (RTINT) increments various counters on each interrupt. These counters are then cleared and sampled by ALPHA to time out pre-set intervals like the foreperiod or the intertrial interval and to measure the subject's latency. Any of the counters defined in RTINT, RTIME, CTDWN, and INTER may be declared displacement externals in ALPHA. The programming for this is quite straightforward, and the examples in ALPHA and RTINT in Appendix D can be examined for more details.

In order to facilitate the user's comprehension of the interprogram relationships in RTLAB, Table 7 presents the associations among subprograms as indexed by .EXTD statements in the relocatable source programs. This table should help the user trace the communications between ALPHA and the other subroutines in Appendix D as he prepares his own version of ALPHA.

One other important user modification needs to be mentioned here. Since the Calma 650 write-only tape unit in our laboratory is not common, most users will want to write their own magnetic tape routines (MTAPE and EOF in our programs) or substitute paper tape, disk storage, or other mass storage routines as appropriate. Table 8 provides the information required to make this substitution and

Table 7. Inter Program Communication in RTLAB

Calling Program	Program Communicated With Directly																		
	RTEXP	DESIGN	ALPHA	RTINT	SCORE	DATYP	RTANL	MTAPE	BMAN	BOX	CARVE	CRTXT	PERMU	ALS	DPACC	INOUT	NZMEM	PROQ	RANDI	EOF
RTEXP		X	X	X	X		X		X							X	X			
DESIG	X				X				X				X			X			X	
ALPHA	X	X		X	X					X		X				X	X			
RTINT	X								X											
SCORE	X																			
DATYP	X	X			X				X							X				
RTANL	X	X			X	X					X				X	X				
MTAPE	X	X			X															X
BMAN																X				
BOX														X						
CARVE																X		X		
CRTXT														X						
PERMU																			X	

Table 8. Organization of Information in RTLAB

Information	Symbolic location[a]	Indirect Address[a] (Symbolic -1)	Program Element
Experiment Identification No.	EXP (Z)		RTEXP
Subject No.	SUBJ (Z)		RTEXP
Group No.	GROUP (Z)		RTEXP
Number of Trials	TRLS (Z)		RTEXP
Number of Stimuli	CT (Z)		RTEXP
Number of Foreperiods	NFP (Z)		RTEXP
Rerun Code (1 = errors rerun, 2 = not rerun)	REPC (Z)		SCORE
Table of Stimuli	CSTAB (N)	ACS (Z)	DESIGN
Table of Correct Responses	RTAB (N)	ARESP (Z)	DESIGN
Table of Foreperiods	FPTAB (N)	AFP (Z)	DESIGN
Table of Stimuli Presented in Session[b]	STIM (N)	ISTIM (Z)	DESIGN
Table of Foreperiods Presented in Session[b]	FORE (N)	IFORE (Z)	DESIGN
Table of Trial Outcomes[b]	CODE (N)	ACODE (Z)	SCORE
Table of Reaction times[b]	TIME (N)	ATIME (Z)	SCORE
Table of Rerun Trials[c]	OVER (N)	AOVER (Z)	SCORE

[a] (Z)=zero page relocatable, (N) = normal relocatable

[b] Stored in a top-to-bottom fashion, such that within the table the first location (e.g., STIM) contains the data for trial n, while the nth location (e.g., STIM+(n-1)) contains it for trial 1.

[c] Stored in the order they were rerun.

additional data found useful in creation of alternate versions of ALPHA. As noted previously, Appendix A shows our tape format as a sample data coding.

Optional modifications. The overall organization of RTLAB as independently assembled relocatable program modules should make it relatively easy for a user to modify any aspects of RTLAB that do not conform to his needs. Each user will have to weigh the utility of modifying our programs versus writing them from scratch. For instance, RTANL is an obvious candidate for modification, but our version is quite long and complex and most user's may find it easiest to use it as is. But should the user want to change or replace any of the routines the information in Tables 7 and 8 and in the Appendices should be quite helpful.

FURTHER INFORMATION

Copies of RTLAB relocatable source program tapes can be obtained from the Data General User's Group by writing to:

Executive Secretary
Data General Users Group
Data General Corporation
Route 9
Southboro, Massachusetts 01772

Further information about RTLAB can be obtained by writing to:

Dr. Gary M. Olson
Department of Psychology
Michigan State University
East Lansing, Michigan 48823

or

Dr. George Moeller
Human Factors Branch
Submarine Medical Research Laboratory
Submarine Base New London
Groton, Connecticut 06340

REFERENCES

1. Smith, E.E. Choice reaction time: An analysis of the major theoretical positions. Psychol Bull. 1968, 69, 77-110.

2. Olson, G.M., & Laxar, K. Asymmetries in processing the terms "right" and "left." J Exp Psychol, 1973, 100, 284-290.

Appendix A

Magnetic Tape Format

In our uses of RTLAB we write the raw data for each subject on magnetic tape for off-line analysis. All data are entered as decimal numbers in ASCII characters. A separate file is written for each subject-session, with five records in each file organized as follows:

Record	Word(s)	Contents
1	1	Experiment Number
	2	Subject Number
	3	Group Number
	4	Number of Trials
	5	Number of Stimuli
	6	Number of Foreperiods
	7	Error Code (1 = all errors rerun, 2 = errors not rerun)
	8-31	Dummy zeroes
2	1-# trials	Stimuli in order presented
3	1-# trials	Foreperiods in order presented
4	1-# trials	Response codes
5	1-# trials	Reaction times in milliseconds

Appendix B

Subroutines of RTEXP and their functions (Arranged alphabetically)

Subroutine Name	Entry Point (all indirect)	Function	Remarks
ALPHA	UQUER	Query experimenter on teletype for parameters needed in ALPHA or its subroutines.	User supplied (JMP Ø, 3 as no-op if no queries)
	PRES	Present a trial, handle response and reaction time so that data are stored via SCORE, present feedback (if any).	User supplied
	ADONE	Inform subject that session is over.	User supplied (JMP Ø, 3 if not used)
	(ARTUP)	Contains address of user's interrupt service routine for RTC, TTY, CRT, or any other devices requesting interrupts during use of RTLAB.	User supplied. In our applications this is in a subroutine of ALPHA.
ALS		Tektronix Corporation PLOT-10 package of CRT subroutines for Nova minicomputers.	
BMAN	AOUTP	Prints text messages on teletype.	
CARVE	CLEVE	Called by RTANL to divide a double precision value by a single precision one and print the results on the teletype in decimal notation.	Quotient is printed but not saved.

Subroutine Name	Entry Point (all indirect)	Function	Remarks
CRTXT	SHOW	Writes text messages on CRT.	
DATYP	ADAT	Lists raw data by trials in teletype.	
DESIGN	ABEGIN	Queries experimenter for all the basic parameters for designing and running a reaction time experiment. If it recognizes the experiment identification number it assumes it already knows all the basic parameters. Upon return it has constructed tables of appropriately randomized stimulus codes and foreperiods for the sequence of trials.	
	AFORE	Returns foreperiod value for current trial to location FP in RTEXP.	
	ASTIM	Returns stimulus code for current trial to location CS in RTEXP.	
DPACC	QUACC	Called by RTANL to selectively accumulate data in a double precision register.	
EOF	AEOF	Called by MTAPE to write end-of-file marks.	
INOUT		General teletype subroutine package.	All based on Data General routines.
	APUTC	Transmit ASCII character to teletype from CPU.	

Subroutine Name	Entry Point (all indirect)	Function	Remarks
INOUT cont.	AGETC	Transmit ASCII character to CPU from teletype.	
	IGETI	Entry into GETC if via TTY interrupt.	
	ABNOC	Binary to octal conversion (CPU → TTY).	
	AOCBN	Octal to binary. (TTY → CPU).	
	ABNDC	Binary to decimal.	Suppresses leading zeroes but does right justify.
	ADCBN	Decimal to binary.	
MTAPE	AWERB	Write raw data via Calma unit on magnetic tape.	
NZMEM	ACLER	Clears adjacent memory locations.	
PERMUTE	APRMT	Produces one random permutation of n adjacent memory locations. Called by DESIGN to randomize sequence of trials.	
PROQ		Data General package for unsigned multiply-divide. Equivalents in Data General notation are:	
	MONK	.MPYU	
	AMOEB	.DIVU	
	NUN	.MPYA	
	ALGAE	.DIVI	

Subroutine Name	Entry Point (all indirect)	Function	Remarks
RANDI	ARAND	Data General random number generator. Called by PERMUTE.	Seed is controlled originally by DESIGN and then by successive calls to RANDI.
RTANL	PSYCH	Provides simple data analysis.	Analysis is not stored, but is printed directly on teletype.
RTINT	ARTUP	Interrupt service routine for illustrative application.	
SCORE	ASCORE	Scores and stores responses and reaction times on each trial.	
	ACODE	Contains address-1 of table of responses, scored as: 1 = correct 2 = error 3 = min, max time	
	ATIME	Contains address-1 of table of reaction times.	
	AOVER	Contains address-1 of table of trial numbers to be run over.	

Appendix C

Flow-Charts of Primary Routines of RTLAB

This appendix contains flow-charts of the following routines:

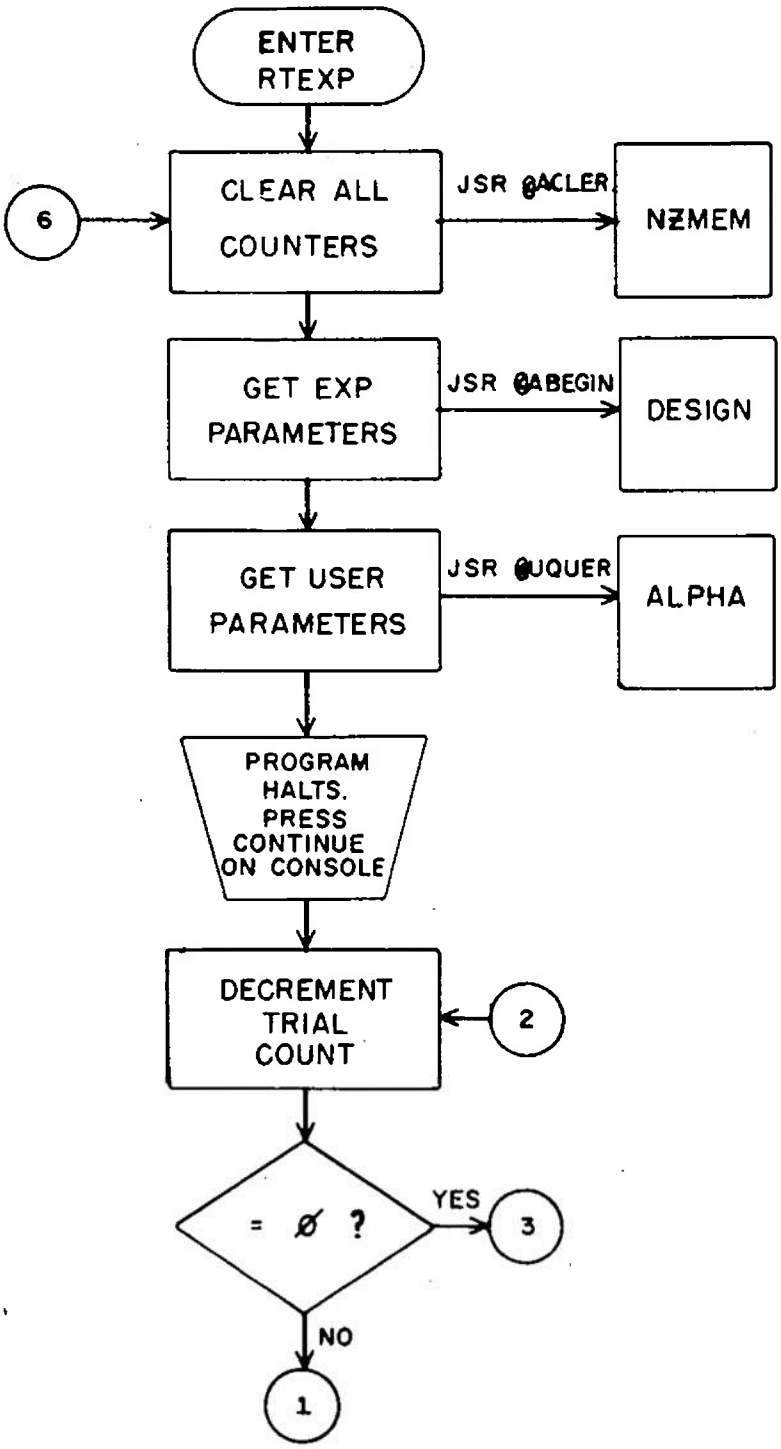

Fig. C-1. Flow-chart for main routine RTEXP. (Part 1 of 4 parts)

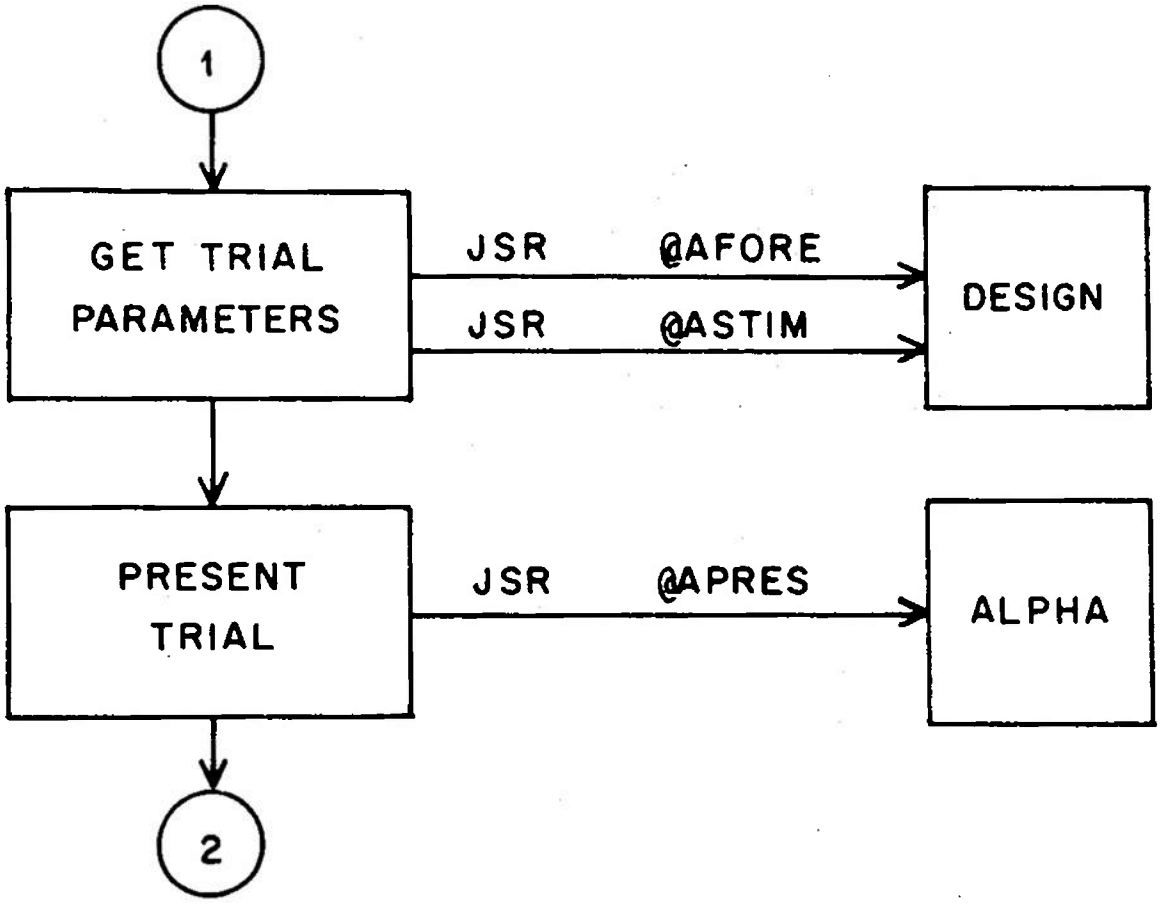

Fig. C-1. Flow-chart for main routine RTEXP. (Part 2 of 4 parts)

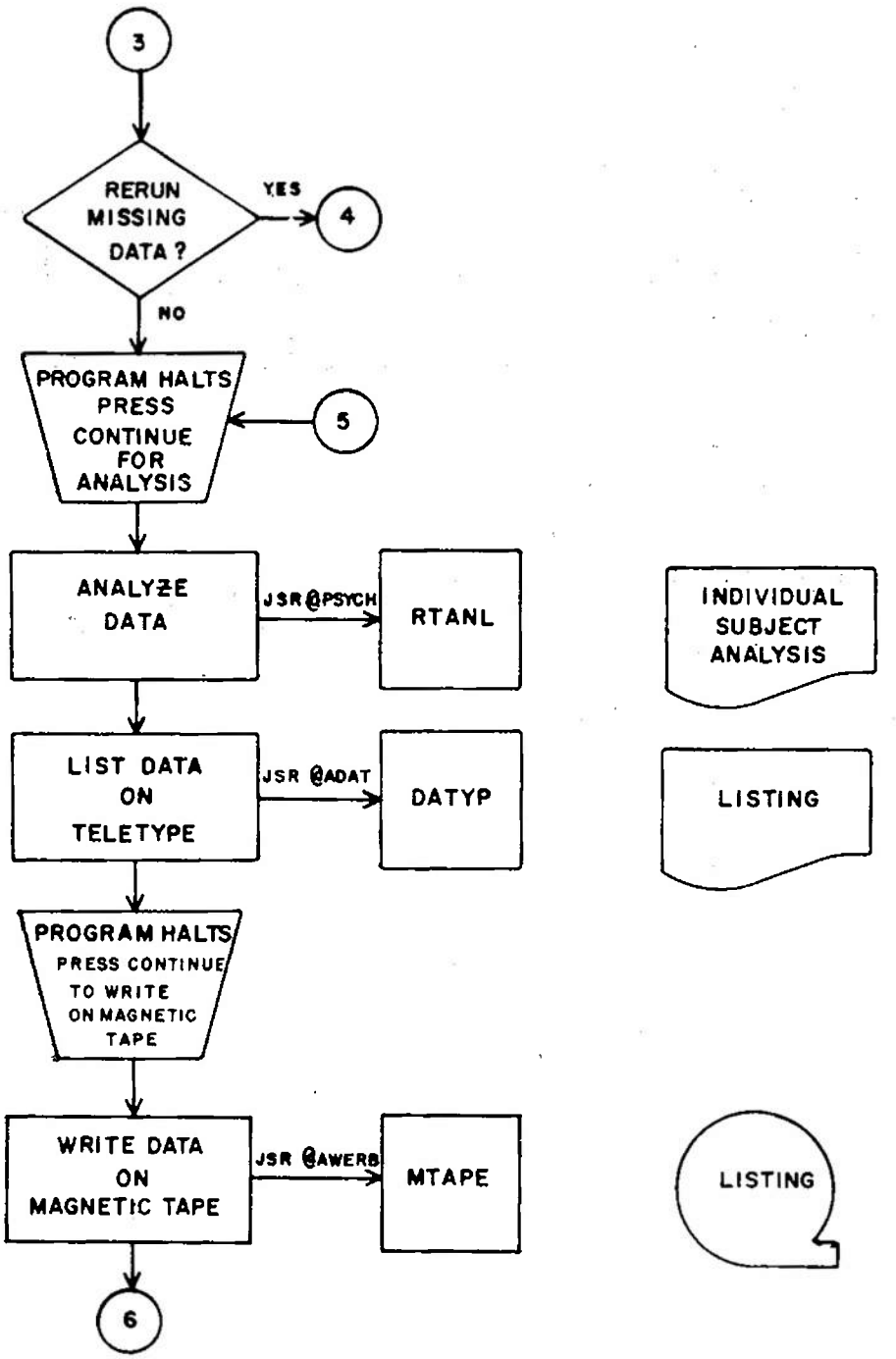

Fig. C-1. Flow-chart for main routine RTEXP. (Part 3 of 4 parts)

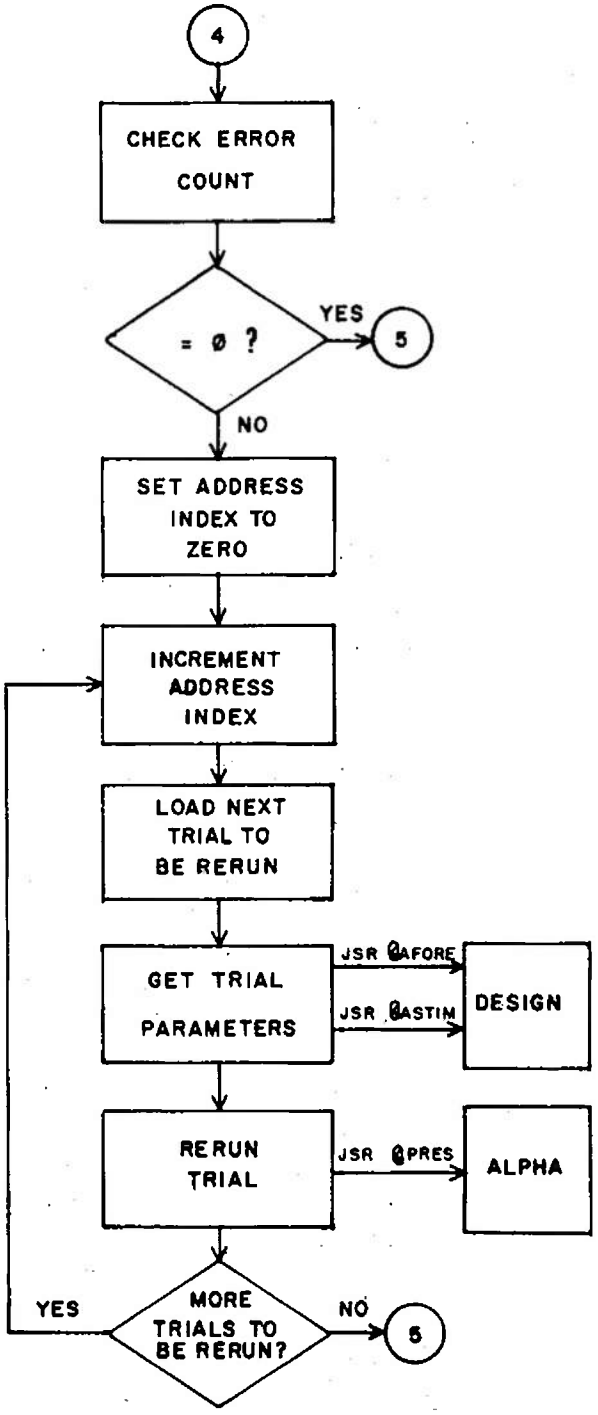

Fig. C-1. Flow-chart for main routine RTEXP. (Part 4 of 4 parts)

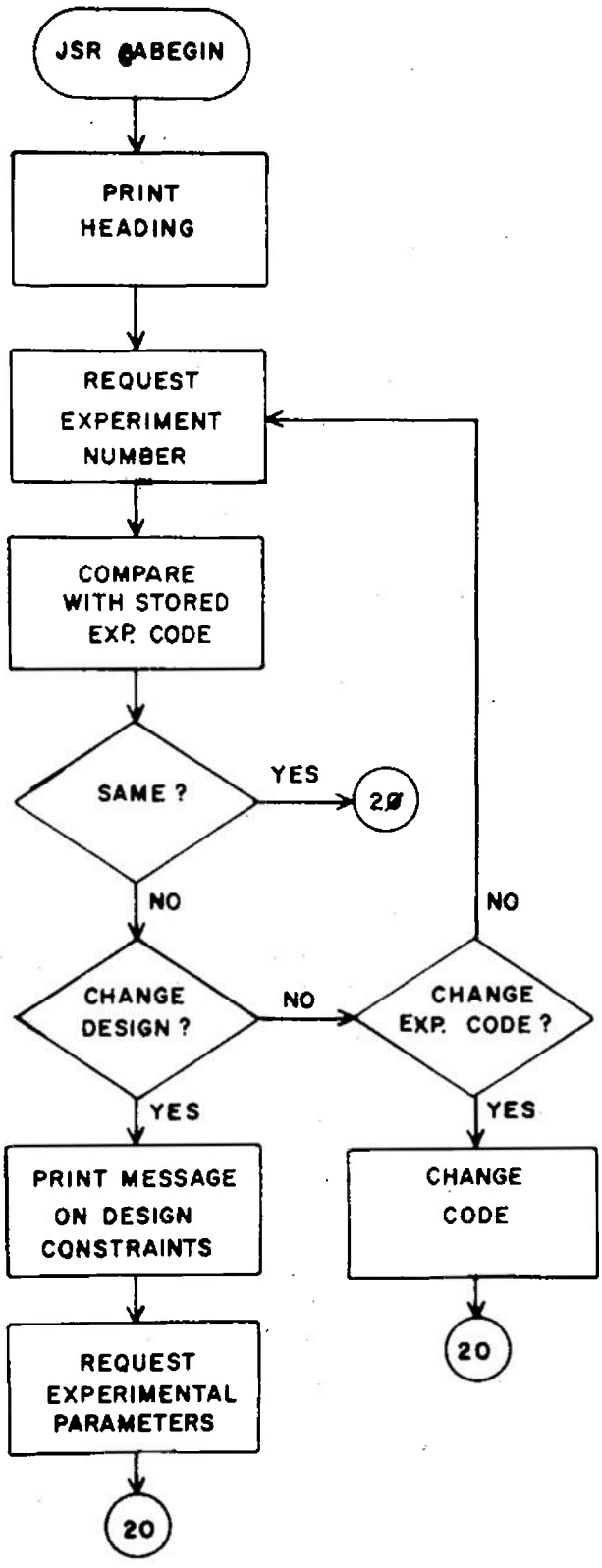

Fig. C-2. Flow-chart for subroutine DESIGN. (Part 1 of 2 parts)

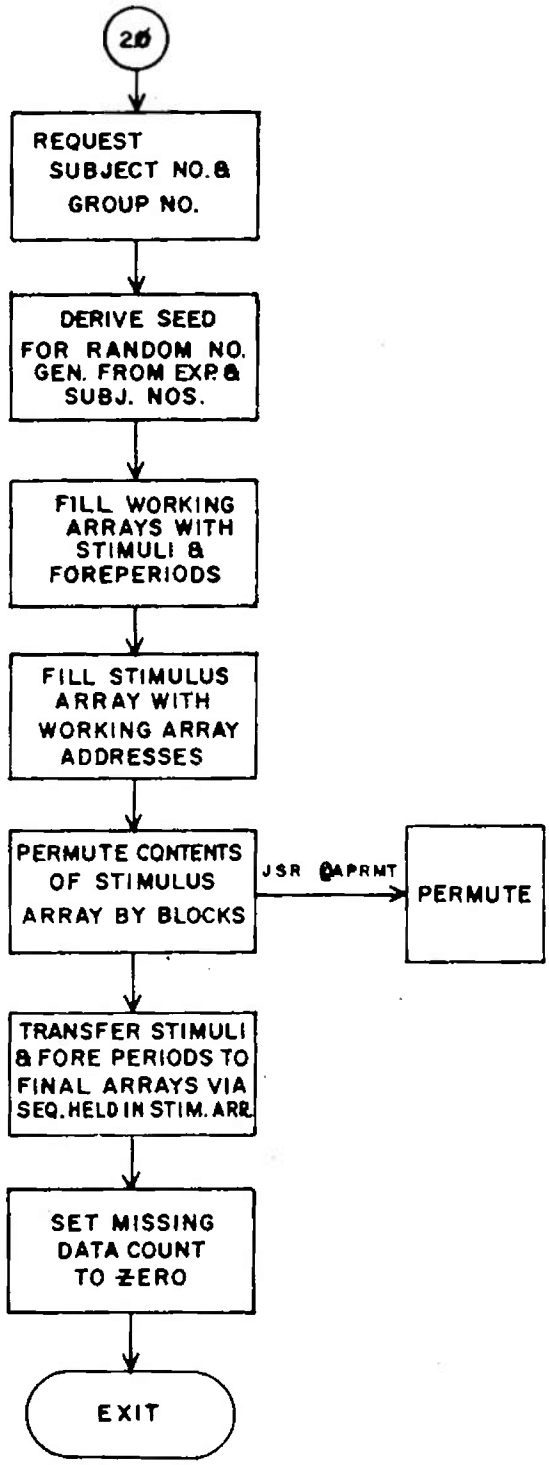

Fig. C-2. Flow-chart for subroutine DESIGN. (Part 2 of 2 parts)

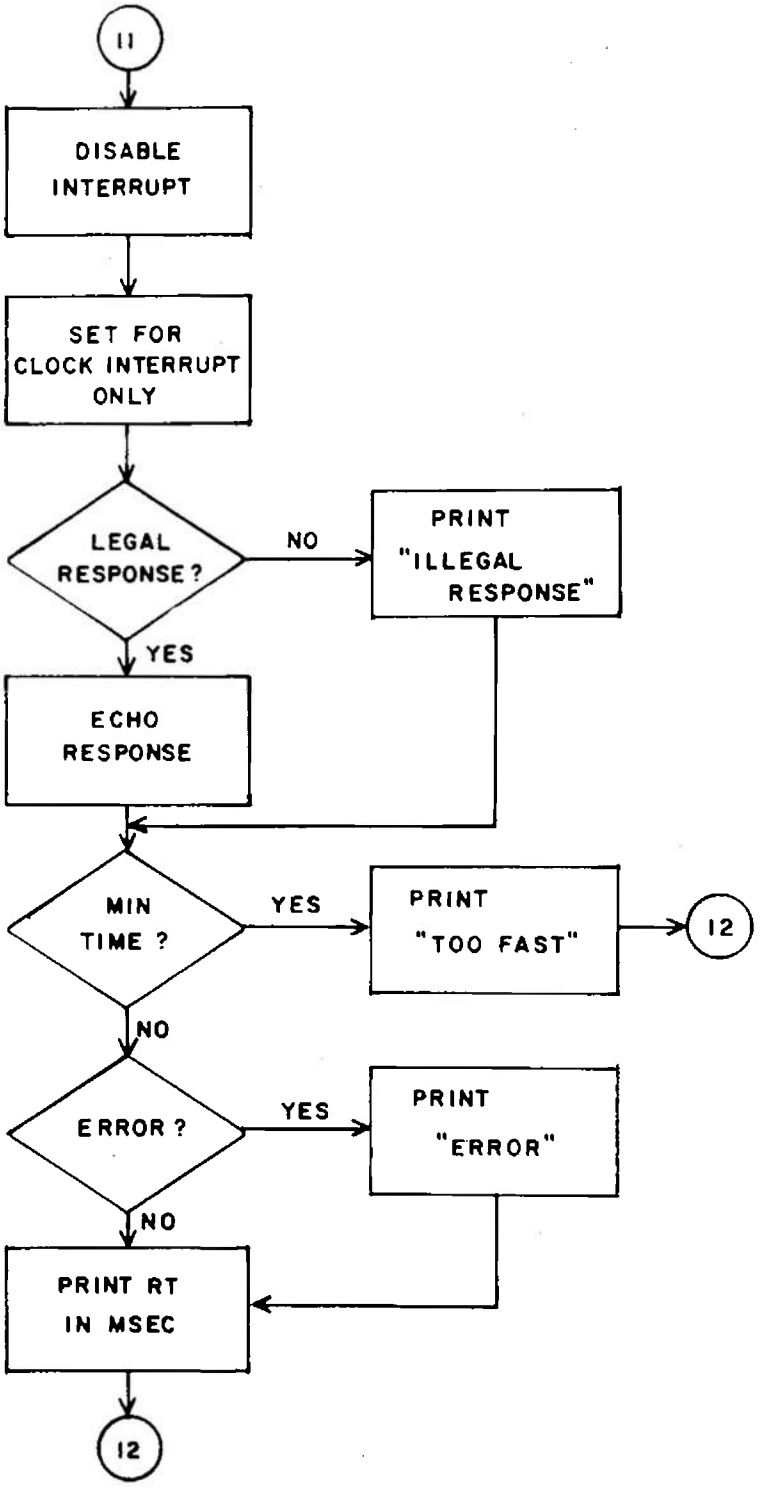

Fig. C-3. Flow-chart for subroutine ALPHA for the experiment discussed in the text. (Part 3 of 4 parts)

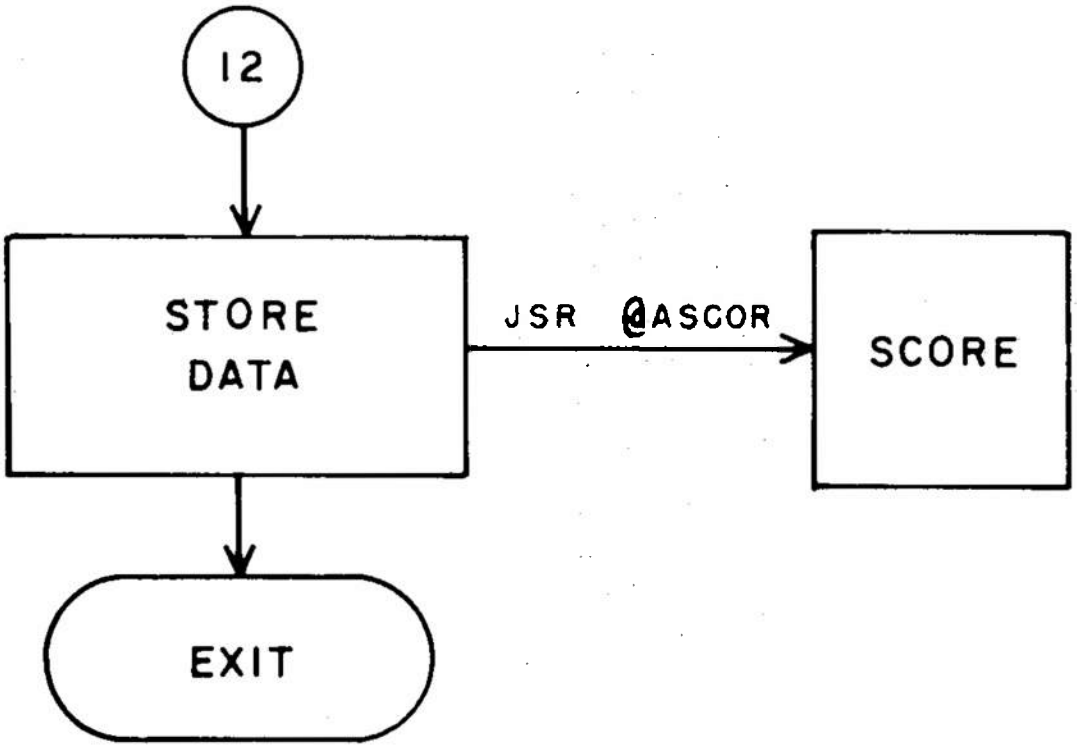

Fig. C-3. Flow-chart for subroutine ALPHA for the experiment discussed in the text. (Part 4 of 4 parts)

Appendix D

Program Listings

All program components of RTLAB are listed in this appendix as output from the NOVA extended assembler. All are in relocatable form. The name or names of the programmer(s) appears in the heading of each listing, along with general information on the use of the routine. Dates and parenthesized letters identify the edition of the subprogram. The listings are in the following order:

```
;RTEXP -- MAIN PROGRAM FOR REACTION TIME
;        GENERAL PURPOSE: USER SUPPLIES
;        ROUTINES TO INTERFACE THIS PROGRAM
;        AND ITS PRIMARY SUBROUTINES WITH
;        PARTICULAR DISPLAY AND RESPONSE DEVICES
;
;FOLLOWING SUBROUTINES (WITH ENTRY POINTS) ARE
;        REQUIRED:
;          1. DESIGN (ABEGIN,AFORE,ASTIM) -- ENTER
;                PARAMETER OF EXPERIMENT, SET UP RUN,
;                SUPPLY FOREPERIOD, STIMULUS AND
;                RESPONSE CODES DURING RUN
;       **2.  ALPHA (PRES,ARTUP,ADONE,UQUER,PHALF) --
;                ROUTINE TO INTERFACE DISPLAY AND
;                RESPONSE DEVICES WITH RTEXP. MUST
;                INCLUDE INTERRUPT SERVICE ROUTINES.
;                CALL VIA ADONE PRESENTS SIGNAL TO
;                SUBJECT THAT EXPERIMENT IS OVER, VIA
;                PHALF THAT EXPERIMENT IS HALF OVER.
;                CALL VIA UQUER ALLOWS THE ENTRY OF
;                USER-SPECIFIC PARAMETERS DURING THE
;                DESIGN OF THE EXPERIMENT.  THE CALLS
;                ADONE,PHALF, AND UQUER CAN, OF COURSE,
;                BE NO-OPS IN THE USER'S PROGRAM.
;          3. NZMEM (ACLER) -- CLEARS MEMORY
;                LOCATIONS
;          4. BMAN (AOUTP) -- PRINTS MESSAGES
;          5. DATYP (ADAT) -- PRINTS DATA ON TTY
;       ++6. MTAPE (AWERB) -- WRITES DATA
;                ON MAGNETIC TAPE
;       ++7. EOF (AEOF) -- CALLED BY MTAPE TO
;                WRITE END OF FILES
;          8. RTANL (PSYCH) -- DOES SIMPLE DATA ANALYSIS
;          9. DPACC (QUACC) -- CALLED BY RTANL TO
;                ACCUMULATE DATA
;          10. CARVE (CLEVE) -- CALLED BY RTANL TO DIVIDE
;                AND PRINT QUOTIENTS
;          11. PROQ (MONK,AMOEB,NUN,ALGAE) -- UNSIGNED
;                DIVIDE, MULTIPLY, CALLED BY CARVE
;          12. INOUT (APUTC,AGETC,ABNOC,AOCBN,ABNDC,
;                ADCBN,IGETI,IDBIN) -- GENERAL
;                TTY SUBROUTINE PACKAGE
;          13. SCORE (ASCOR,ACODE,ATIME,AOVER) --
;                SCORES AND STORES RESPONSES AND
;                REACTION TIMES
;          14. PERMUTE (APRMT) -- PRODUCES RANDOM
;                PERMUTATIONS OF MEMORY LOCATIONS,
;                CALLED BY DESIGN
;          15. RANDI (ARAND) -- RANDOM NUMBER GENERATOR
;                CALLED BY PERMUTE
;       ** USER SUPPLIED
;       ++ USER MAY NEED TO ADAPT FOR OWN TAPE UNIT
;
;RTEXP BEGINS BY QUERYING USER ABOUT THE
;        DESIGN OF THE EXPERIMENT.  THEN IT SETS
;        UP A RUN FOR AN INDIVIDUAL SUBJECT
;        AND HALTS, ALLOWING EXPERIMENTER TO START
;        THE EXPERIMENT BY PRESSING "CONTINUE"
;        ON THE CONSOLE.  WHEN SESSION IS OVER,
;        A MESSAGE IS GIVEN TO SUBJECT
```

```
                ;       AND RTEXP HALTS.  THE DATA
                ;       LISTING AND ANALYSIS ROUTINES CAN
                ;       THEN BE STARTED WITH "CONTINUE"
                ;
                ;               G.O. MOELLER & G.M. OLSON
                ;               6 APRIL 1973 (A)

                        .TITL   RTEXP
                        .EXTD   ARTUP,ACLER,ABEGIN,AFORE,ASTIM,
                        .EXTD   AOUTP,AENDC,APUTC,ASCOR,PPES,ADONE
                        .ENT    AMAIN,ARAP,INTER,CTDWN,RTIME
                        .ENT    CLMSK,RESP,TTIME,SEC
                        .ENT  EXP,SUBJ,GROUP,TRLS,ITI,MAX,MIN
                        .ENT  FP,CT,CS,CTRLS,NFP,CRESP,NOVER
                        .EXTD AWERB,REPC,OVINC,AOVER,PSYCH,AGETC
                        .EXTD   ARE,ATYPE,ADAT,UQUER
      102513    .DALC   SGT=SUBL# 0,0,SNC       ;SGT A,B.       A.GT.B
      102113    .DALC   SGE=ADCL# 0,0,SNC       ;SGE A,B.       A.GE.B
      102512    .DALC   SLE=SUBL# 0,0,SZC       ;SLE A,B.       A.LE.B
      102112    .DALC   SLT=ADCL# 0,0,SZC       ;SLT A,B.       A.LT.B
                        .ZREL
00000-177773    CLMSK:  177773          ;RTC INTERRUPT ONLY
00001-000000    MIN:    0               ;LB ON RT
00002-000000    MAX:    0               ;UB ON RT
00003-000000    ITI:    0               ;INTER-TRIAL INTERVAL
00004-000000    TRLS:   0               ;# TRIALS
00005-000000    CT:     0               ;# STIMULI
00006-000000    GROUP:  0               ;GROUP #
00007-000000    SUBJ:   0               ;SUBJ #
00010-000000    NFP:    0               ;# FP
00011-000000    EXP:    0               ;EXP ID
00012-000000    CRESP:  0               ;CORRECT RESPONSE CODE
00013-000000    NOVER:  0               ;CUMULATIVE RERUN TRIALS
00014-000000    FP:     0               ;FOREPERIOD
00015-000000    CS:     0               ;STIMULUS CODE
00016-000000    SEC:    0
00017-000000    MSEC:   0
00020-000000    INTER:  0               ;ELAPSED ITI
00021-000000    CTDWN:  0               ;ELAPSED FP
00022-000000    RTIME:  0               ;ELAPSED RT
00023-000000    TTIME:  0
00024-000000    TEMP:   0
00025-000000    RESP:   0               ;RESPONSE
00026-000000    CTRLS:  0               ;TRIAL COUNTER
00027-000003    CLKFQ:  3
00030-000006            6
00031-000136'   ARAP:   RAPUP
00032-000000'   AMAIN:  MAIN
00033-000002'   AHOP:   MAIN+2
      000003    BLOC1:  .BLK 3


                        .NREL
      000050            CRI=50
      000051            CRO=51
                ;
00000'060277    MAIN:   INTDS
00001'060214            NIOC    RTC
00002'020001$           LDA     0,ARTUP ;ISR ADDRESS TO LOC 1
00003'040001            STA     0,1
```

```
00004'006002$           JSR@    ACLER   ;SET (SEC) TO (SEC + 8) = 0
00005'000011            11
00006'000016-           SEC
00007'006003$           JSR     @ABEGIN ;ENTER PARAMETERS
00010'006025$           JSR     @UQUER  ;ENTER USER PARAMTERS
00011'020404            LDA     0,MTXT  ;HALT TO ALLOW EXPERIMENTER
00012'006023$           JSR     @ATYPE  ;TO READY SUBJECT
00013'063077            HALT
00014'000426            JMP     GOGO
00015'000016' MTXT:     TXT4
00016'005015  TXT4:     .TXT *<15><12>
00017'020012  <12>
00020'051120  PR
00021'051505  ES
00022'020123  S
00023'047503  CO
00024'052116  NT
00025'047111  IN
00026'042525  UE
00027'052040   T
00030'020117  O
00031'052123  ST
00032'051101  AR
00033'020124  T
00034'042523  SE
00035'051523  SS
00036'047511  IO
00037'027116  N.
00040'005015  <15><12>
00041'000000  *
              ;
00042'020004- GOGO:     LDA     0,TRLS
00043'040026-           STA     0,CTRLS
00044'020000-           LDA     0,CLMSK ;ENABLE RTC
00045'062177            DOBS    0,CPU   ;INTERPUPT
00046'010026-           ISZ     CTRLS
00047'020027-           LDA     0,CLKFQ ;RTC@1KHZ + START
00050'061114            DOAS    0,RTC

00051'014026- AGIN:     DSZ     CTRLS   ;DEC TRIALS CTR
00052'006004$           JSR@    AFORE   ;SELECT FP, RETURN (PC+2)
00053'000425            JMP FINIS       ;EXIT
00054'006005$           JSR@    ASTIM   ;SELECT STIMULUS
                                        ;STIM CODE TO CS
                                        ;CORRECT RESP. CODE TO CRESP
00055'004402            JSR TRIAL       ;RUN CURRENT TRIAL
00056'000773            JMP AGIN

00057'054420  TRIAL:    STA 3,NEXT      ;SAVE RETURN
00060'024003- TOVER:    LDA     1,ITI   ;TRIAL OVER ?
00061'020020-           LDA     0,INTEP
00062'106113            SGE     0,1
00063'000776            JMP     .-2

00064'060277            INTDS
00065'060214            NIOC    RTC
00066'006002$           JSR@    ACLER   ;RESET TIMES
00067'000010            10
00070'000016-           SEC
00071'006012$           JSR     @PRES   ;TIME OUT THE
```

```
                                        ;FOREPERIOD, PRESENT
                                        ;THE STIMULUS, RECORD
                                        ;THE RESPONSE
00072'020440            LDA 0,ZERO
00073'040020-           STA 0,INTER
00074'060114            NIOS RTC
00075'060177            INTEN
00076'002401            JMP @NEXT
00077'000000  NEXT:     0
00100'020015$ FINIS:    LDA 0,REPC      ;GET RERUN INDICATOR
00101'024432            LDA 1,ONE       ;GET CONSTANT = 1
00102'106414            SUB# 0,1,SZR    ;RERUN?
00103'000433            JMP RAPUP       ;  NO
00104'020016$           LDA 0,OVINC     ;  YES -- CHECK IF
00105'024425            LDA 1,ZERO      ;ANYTHING TO RERUN
00106'106415            SUB# 0,1,SNR    ;
00107'000427            JMP RAPUP
00110'024422            LDA 1,ZERO      ;SET RERUN COUNTER
00111'044420            STA 1,MARK      ;TO 0
00112'020016$           LDA 0,OVINC
00113'040013-           STA 0,NOVER     ;STORE RERUN COUNT
00114'020017$ STL:      LDA 0,AOVER     ;GET ADDRESS OF
00115'010414            ISZ MARK        ;RERUN TABLE & CURRENT
00116'030413            LDA 2,MARK      ;COUNT
00117'113000            ADD 0,2
00120'025000            LDA 1,0,2
00121'044026-           STA 1,CTRLS     ;SET TRIAL COUNT
00122'006004$           JSR @AFORE
00123'000000            0
00124'006005$           JSR @ASTIM
00125'004732            JSR TRIAL
00126'014013-           DSZ NOVER
00127'000765            JMP STL
00130'000406            JMP RAPUP
00131'000000  MARK:     0
00132'000000  ZERO:     0
00133'000001  ONE:      1
00134'000166' ATAPE:    TXTP
00135'000213' ADO:      ANALS
              ;
00136'024003- RAPUP:    LDA     1,ITI
00137'020020-           LDA     0,INTER
00140'106113            SGE     0,1
00141'000776            JMP     .-2
00142'060277            INTDS
00143'060214            NIOC    RTC
00144'060250            NIOC    CRI
00145'006013$           JSR     @ADONE
00146'020767            LDA     0,ADO
00147'101120            MOVZL   0,0
00150'040402            STA     0,.+2
00151'006006$           JSR     @AOUTP
00152'000000            0
00153'063077            HALT
00154'006020$           JSR     @PSYCH
00155'006024$           JSR     @ADAT
00156'020756            LDA 0,ATAPE     ;WRITE MESSAGE RE TAPE
00157'101120            MOVZL 0,0
00160'040402            STA 0,.+2
00161'006006$           JSR @AOUTP
```

```
00162'000000            0
00163'063077            HALT
00164'006014$           JSR @AWERB
00165'002033-           JMP @AHOP
00166'005015  TXTP:     .TXT /<15><12>
00167'005012  <12><12>
00170'047515  MO
00171'047125  UN
00172'020124  T
00173'047101  AN
00174'020104  D
00175'042522  RE
00176'042101  AD
00177'020131  Y
00200'040524  TA
00201'042520  PE
00202'020054  ,
00203'051120  PR
00204'051505  ES
00205'020123  S
00206'047503  CO
00207'052116  NT
00210'047111  IN
00211'042525  UE
00212'000056  ./
00213'005015  ANALS:    .TXT/<15><12>
00214'051120  PR
00215'051505  ES
00216'020123  S
00217'047503  CO
00220'052116  NT
00221'047111  IN
00222'042525  UE
00223'043040   F
00224'051117  OR
00225'040440   A
00226'040516  NA
00227'054514  LY
00230'044523  SI
00231'000123  S/
                        .END
```

```
                ; SUBROUTINE ALPHA -- INTERFACES RTEXP WITH
                ; CRT FOR SIMPLE RIGHT-LEFT RESEARCH
                ;(AFTER OLSON & LAXAR, JEP, 1973)
                ;
                ;               ENTRY POINTS:
                ;                       1.  UQUER -- FOR USER-SPECIFIC
                ;                               PARAMETERS
                ;                       2.  PRES -- FOR EACH TRIAL
                ;                       3.  ADONE --  WHEN RUN IS OVER
                ;
                ;               USES SUBROUTINES
                ;                       1.  BOX
                ;                       2.  SCOPE
                ;                       3.  RTINT
                ;                       4.  CRTXT
                ;                       5.  NZMEM
                ;                       6.  BMAN
                ;                       AND THEIR ASSOCIATED ROUTINES
                ;
                ;
                ;               G.M. OLSON
                ;               5 JUNE 1973 (A)


                                .TITL ALPHA
                                .ENT UQUER,PPES,ADONE
                                .EXTD ARTUP,FP,CS,RTIME,MAX,MIN
                                .EXTD CPRESP,RESP,CTDWN,TTIME,ASCOR
                                .EXTD CLMSK,ACLER,SEC,PLBOX
                                .EXTD SHOW,ATYPE,AGETC

                        .ZREL
00000-000064'  ATRUE:   TRUE
00001-000065'  AFALSE:  FALSE
00002-000000'  PRES:    DSPLY
00003-000612'  ADONE:   FINIS
00004-000544'  CLEAR:   BLAST
00005-000402'  YTIME:   TIME
00006-000066'  PRINT:   WRITE
00007-000660'  UQUER:   ASK
00010-177771   GMASK:   177771
      000050            CRI=50
      000051            CRO=51
      102113            .DALC   SGE=ADCL# 0,0,SNC

                        .NREL
00000'054533   DSPLY:   STA 3,EXIT       ;SAVE RETURN
00001'006004-           JSR @CLEAR       ;ERASE CRT
00002'060250            NIOC CRI         ;WAIT FOR SUBJ
00003'063650            SKPDN CRI        ;TO START TRIAL
00004'000777            JMP .-1
00005'020544            LDA 0,AREDY      ;START
00006'006006-           JSR @PRINT
00007'020541            LDA 0,ZEROX
00010'040011$           STA 0,CTDWN
00011'060114            NIOS RTC
00012'060177            INTEN
                                         ;COUNT OUT FP
00013'024002$  FPOVR:   LDA 1,FP
00014'020011$           LDA 0,CTDWN
```

```
00015'106113            SGE 0,1
00016'000776            JMP .-2
                                        ;CLEAR CRT, PPESENT STIM
00017'060277  CSON:     INTDS
00020'060214            NIOC RTC
00021'063551            SKPBZ CRO
00022'000777            JMP .-1
00023'020003$           LDA 0,CS
00024'040402            STA 0,.+2
00025'006017$           JSR @FLBOX
00026'000000            0
00027'020010-           LDA 0,GMASK
00030'060150            NIOS CPI
00031'060114            NIOS RTC
00032'062177            DOBS 0,CPU
                                        ;CHECK FOR RESPONSE
                                        ;OR FOR MAX TIME
00033'020515  TLIM:     LDA 0,ZEROX
00034'040004$           STA 0,RTIME
00035'024005$           LDA 1,MAX
00036'063450            SKPBN CRI
00037'000413            JMP SOME
00040'020004$           LDA 0,RTIME
00041'106113            SGE 0,1         ;MAX TIME?
00042'000774            JMP .-4
00043'004475  SLOW:     JSR RERUN       ;TOO SLOW
00044'006004-           JSR @CLEAR
00045'020505            LDA 0,AOVTM
00046'006006-           JSR @PRINT
00047'020500            LDA 0,THREE
00050'006013$           JSR @ASCOR
00051'002462            JMP @EXIT
                                        ;ECHO RESPONSE
00052'004466  SOME:     JSR RERUN
00053'006004-           JSR @CLEAR
00054'020010$           LDA 0,RESP
00055'024407            LDA 1,TRUE
00056'106415            SUB# 0,1,SNR
00057'000415            JMP TRESP
00060'024405            LDA 1,FALSE
00061'106415            SUB# 0,1,SNR
00062'000417            JMP FRESP
00063'000423            JMP IRESP
00064'000000  TRUE:     0
00065'000000  FALSE:    0
00066'054446  WRITE:    STA 3,EXIT+1
00067'101120            MOVZL 0,0
00070'040402            STA 0,SEA
00071'006020$           JSR @SHOW
00072'000000  SEA:      0
00073'002441            JMP @EXIT+1
00074'020460  TRESP:    LDA 0,ATWRD
00075'006006-           JSR @PRINT
00076'020447            LDA 0,ONES
00077'040010$           STA 0,RESP
00100'000412            JMP LAN
00101'020454  FRESP:    LDA 0,AFWRD
00102'006006-           JSR @PRINT
00103'020443            LDA 0,TWO
00104'040010$           STA 0,RESP
```

```
00105'000405            JMP LAN
00106'020450  IRESP:    LDA 0,AIWRD
00107'006006-           JSR @PRINT
00110'020437            LDA 0,THREE
00111'040010$           STA 0,RESP
00112'063551  LAN:      SKPBZ CRO           ;ECHO COMPLETE?
00113'000777            JMP .-1
00114'020012$           LDA 0,TTIME         ;CHECK IF RESPONSE TOO FAST
00115'024006$           LDA 1,MIN
00116'106113            SGE 0,1
00117'000416            JMP QUICK
                                            ;CHECK RESPONSE
00120'030007$           LDA 2,CRESP
00121'024010$           LDA 1,RESP
00122'020423            LDA 0,ONES
00123'132405            SUB 1,2,SNR
00124'000404            JMP RECRD           ;RECORD CORRECT RESP
00125'020432            LDA 0,AERR          ;TELL S, "ERROR"
00126'006006-           JSR @PRINT
00127'020417            LDA 0,TWO
00130'006013$ RECRD:    JSR @ASCOR
00131'006005-           JSR @YTIME
00132'002401            JMP @EXIT
      000002  EXIT:     .BLK 2

00135'004403  QUICK:    JSR RERUN
00136'020415            LDA 0,AFAST
00137'000707            JMP SLOW+3

00140'060277  RERUN:    INTDS               ;RESET ISR
00141'060250            NIOC CRI            ;FOR RTC ONLY
00142'020014$           LDA 0,CLMSK
00143'062177            DOBS 0,CPU
00144'001400            JMP 0,3

00145'000001  ONES:     1
00146'000002  TWO:      2
00147'000003  THREE:    3
00150'000000  ZEROX:    0
00151'000160' AREDY:    REDY
00152'000162' AOVTM:    OVTM
00153'000213' AFAST:    FAST
00154'000245' ATWRD:    TWRD
00155'000273' AFWRD:    FWRD
00156'000322' AIWRD:    IWRD
00157'000356' AERR:     ERROR
00160'003440  REDY:     .TXT * <7>
00161'000040   *
00162'005015  OVTM:     .TXT *<15><12>
00163'005012  <12><12>
00164'005012  <12><12>
00165'005012  <12><12>
00166'020040
00167'020040
00170'020040
00171'020040
00172'020040
00173'020040
00174'020040
00175'020040
```

```
00176'020040
00177'020040
00200'020040
00201'020040
00202'020040
00203'020040
00204'020040
00205'020040
00206'052040    T
00207'047517   OO
00210'051440    S
00211'047514   LO
00212'000127   W*
00213'005015   FAST:    .TXT *<15><12>
00214'005012   <12><12>
00215'005012   <12><12>
00216'005012   <12><12>
00217'020040
00220'020040
00221'020040
00222'020040
00223'020040
00224'020040
00225'020040
00226'020040
00227'020040
00230'020040
00231'020040
00232'020040
00233'020040
00234'020040
00235'020040
00236'020040
00237'052040    T
00240'047517   OO
00241'043040    F
00242'051501   AS
00243'020124   T
00244'000000   *
00245'005015   TWPD:    .TXT *<15><12>
00246'005012   <12><12>
00247'005012   <12><12>
00250'005012   <12><12>
00251'020040
00252'020040
00253'020040
00254'020040
00255'020040
00256'020040
00257'020040
00260'020040
00261'020040
00262'020040
00263'020040
00264'020040
00265'020040
00266'020040
00267'020040
00270'051124   TR
00271'042525   UE
```

```
00272'000040   *
00273'005015  FWRD:    .TXT *<15><12>
00274'005012  <12><12>
00275'005012  <12><12>
00276'005012  <12><12>
00277'020040
00300'020040
00301'020040
00302'020040
00303'020040
00304'020040
00305'020040
00306'020040
00307'020040
00310'020040
00311'020040
00312'020040
00313'020040
00314'020040
00315'020040
00316'040506  FA
00317'051514  LS
00320'020105  E
00321'000000  *
00322'005015  IWRD:    .TXT *<15><12>
00323'005012  <12><12>
00324'005012  <12><12>
00325'005012  <12><12>
00326'020040
00327'020040
00330'020040
00331'020040
00332'020040
00333'020040
00334'020040
00335'020040
00336'020040
00337'020040
00340'020040
00341'020040
00342'020040
00343'020040
00344'020040
00345'046111  IL
00346'042514  LE
00347'040507  GA
00350'020114  L
00351'042522  RE
00352'050123  SP
00353'047117  ON
00354'042523  SE
00355'000040   *
00356'005015  ERROR:   .TXT *<15><12>
00357'020040
00360'020040
00361'020040
00362'020040
00363'020040
00364'020040
00365'020040
```

```
00366'020040
00367'020040
00370'020040
00371'020040
00372'020040
00373'020040
00374'020040
00375'020040
00376'051105  ER
00377'047522  RO
00400'020122  R
00401'000000  *

00402'054464  TIME:   STA 3,IOTA
00403'020472          LDA 0,ATTXT
00404'006006-         JSR @PRINT
00405'024004$         LDA 1,RTIME      ;ENDEC FOR CRT
00406'034575          LDA 3,ZERO
00407'054461          STA 3,XI
00410'034462          LDA 3,FIVE
00411'054460          STA 3,LAST
00412'034450          LDA 3,INST
00413'054401          STA 3,.+1
00414'000000  LOOP:   0
00415'020452          LDA 0,C60
00416'146443          SUBO 2,1,SNC
00417'101401          INC 0,0,SKP
00420'147001          ADD 2,1,SKP
00421'000775          JMP .-3
00422'050442          STA 2,KEEP
00423'014446          DSZ LAST
00424'000402          JMP .+2
00425'000420          JMP TAU
00426'034442          LDA 3,XI
00427'030554          LDA 2,ZERO
00430'156414          SUB# 2,3,SZR
00431'000414          JMP TAU
00432'030441          LDA 2,ONE
00433'034434          LDA 3,C60
00434'116414          SUB# 0,3,SZR
00435'000407          JMP TAU-1
00436'040427          STA 0,KEEP+1
00437'020424          LDA 0,BLANK
00440'004440          JSR KAPPA
00441'020424          LDA 0,KEEP+1
00442'030422          LDA 2,KEEP
00443'000404          JMP TAU+2
00444'050424          STA 2,XI
00445'004433  TAU:    JSR KAPPA
00446'030416          LDA 2,KEEP
00447'010745          ISZ LOOP
00450'151203          MOVR 2,2,SNC
00451'000743          JMP LOOP
00452'020422          LDA 0,AMSEC
00453'006006-         JSR @PRINT
00454'002412          JMP @IOTA
      000012          .RDX 10
00455'023420  TENS:   10000
00456'001750          1000
00457'000144          100
```

```
00460'000012            10
00461'000001            1
      000010            .RDX 8
00462'030441  INST:     LDA 2,.+TENS-LOOP
00463'000040  BLANK:    40
      000002  KEEP:     .BLK 2
00466'000000  IOTA:     0
00467'000060  C60:      60
00470'000000  XI:       0
00471'000000  LAST:     0
00472'000005  FIVE:     5
00473'000001  ONE:      1
00474'000534' AMSEC:    MSEC
00475'000510' ATTXT:    TTXT
00476'030410            LDA 2,CONS
00477'050410            STA 2,IDIOT
00500'063551  KAPPA:    SKPBZ CRO
00501'000777            JMP .-1
00502'014405            DSZ IDIOT
00503'000777            JMP .-1
00504'061151            DOAS 0,CRO
00505'001400            JMP 0,3
00506'000250  CONS:     250
00507'000000  IDIOT:    0

00510'005015  TTXT:     .TXT *<15><12>
00511'020040
00512'020040
00513'020040
00514'020040
00515'020040
00516'020040
00517'020040
00520'020040
00521'020040
00522'020040
00523'020040
00524'020040
00525'020040
00526'020040
00527'020040
00530'044524  TI
00531'042515  ME
00532'036440   =
00533'000040   *
00534'046440  MSEC:     .TXT * M
00535'046111  IL
00536'044514  LI
00537'042523  SE
00540'047503  CO
00541'042116  ND
00542'020123  S
00543'000040   *

00544'054433  BLAST:    STA 3,SAVE
00545'020431            LDA 0,BMSG      ;ERASE CRT
00546'101120            MOVZL 0,0
00547'040402            STA 0,.+2
00550'006020$           JSR @SHOW
00551'000000            0
```

```
00552'020001            LDA 0,1          ;SET UP ISR
00553'040425            STA 0,SAVE+1     ;FOR COMPLETION
00554'020421            LDA 0,ASR        ;OF ERASE
00555'040001            STA 0,1
00556'020425            LDA 0,ZERO
00557'040425            STA 0,COUNT
00560'020014$           LDA 0,CLMSK
00561'062177            DOBS 0,CPU
00562'060114            NIOS RTC
00563'060177            INTEN
00564'024425            LDA 1,INT
00565'020417            LDA 0,COUNT
00566'106113            SGE 0,1          ;ERASE COMPLETED
00567'000776            JMP .-2          ;NO
00570'060277            INTDS            ;YES
00571'060214            NIOC RTC
00572'020406            LDA 0,SAVE+1
00573'040001            STA 0,1
00574'002403            JMP @SAVE
00575'000605' ASR:      ISR
00576'000601' BMSG:     MSG
      000002  SAVE:     .BLK 2
00601'006033  MSG:      .TXT *<33><14>
00602'000000  *
00603'000000  ZERO:     0
00604'000000  COUNT:    0
00605'010777  ISR:      ISZ COUNT
00606'060114            NIOS RTC
00607'060177            INTEN
00610'002000            JMP @0
      000012            .RDX 10
00611'001440  INT:      800

      000010            .RDX 8
00612'054405  FINIS:    STA 3,CHETH
00613'006004-           JSR @CLEAR
00614'020404            LDA 0,ETA
00615'006006-           JSR @PRINT
00616'002401            JMP @CHETH
00617'000000  CHETH:    0
00620'000621  ETA:      ZAYIN
00621'005015  ZAYIN:    .TXT *<15><12>
00622'005012  <12><12>
00623'005012  <12><12>
00624'005012  <12><12>
00625'020040
00626'020040
00627'020040
00630'020040
00631'020040
00632'020040
00633'020040
00634'020040
00635'020040
00636'020040
00637'020040
00640'020040
00641'042440    E
00642'042116  ND
00643'047440    0
```

```
00644'020106  F
00645'042523  SE
00646'051523  SS
00647'047511  IO
00650'027116  N.
00651'020040
00652'044124  TH
00653'047101  AN
00654'020113  K
00655'047531  YO
00656'027125  U.
00657'000040   *

00660'054737  ASK:     STA 3,CHETH
00661'020411           LDA 0,TXTAT
00662'006021$          JSR @ATYPE
00663'006022$          JSR @AGETC
00664'042000-          STA 0,@ATRUE
00665'020406           LDA 0,TXTAF
00666'006021$          JSR @ATYPE
00667'006022$          JSR @AGETC
00670'042001-          STA 0,@AFALSE
00671'002726           JMP @CHETH
00672'000674' TXTAT:   BOZO
00673'000711' TXTAF:   SNUB
00674'005015  BOZO:    .TXT *<15><12>
00675'020012  <12>
00676'052042  "T
00677'052522  PU
00700'021105  E"
00701'041440   C
00702'040510  HA
00703'040522  RA
00704'052103  CT
00705'051105  ER
00706'036440   =
00707'037440   ?
00710'000040   *
00711'005015  SNUB:    .TXT *<15><12>
00712'020012  <12>
00713'043042  "F
00714'046101  AL
00715'042523  SE
00716'020042  "
00717'044103  CH
00720'051101  AR
00721'041501  AC
00722'042524  TE
00723'020122  R
00724'020075  =
00725'020077  ?
00726'000000  *
                      .END
```

```
                ;INTERRUPT SUBRT FOR RT EXPERIMENTS
                ;       USING CRT AND RTC
                ;
                ;  CUMULATE TIME AT CLOCK FREQ IN
                    ;LOCS INTER, CTDWN, + RTIME

                ;       G.O. MOELLER
                ;       MODIFIED -- G.M. OLSON
                ;                   28 FEBRUARY 1973(A)

                ;
                        .TITL RTINT
                        .ENT ARTUP
                        .EXTD   ARAP,AOUTP,CLMSK,TTIME
                        .EXTD   RESP,INTER,CTDWN,RTIME
                        .NREL
                ;
00000'040435    INRUP:  STA     0,CSPAR
00001'061477            DIB     0,CPU
00002'060214            NIOC    RTC
00003'101005            MOV     0,0,SNR
00004'000432            JMP     SRCRT
00005'101200            MOVR    0,0
00006'101200            MOVR    0,0
00007'101202            MOVR    0,0,SZC
00010'000406            JMP     SRCL
00011'101200            MOVR    0,0
00012'101200            MOVR    0,0
00013'101202            MOVR    0,0,SZC
00014'000455            JMP     IOER
00015'000475            JMP     TELE

                ;CLOCK SERVICE ROUTINE
00016'020417    SRCL:   LDA     0,CSPAR ;SAVE AC0
00017'040414            STA     0,CLSV
00020'020000            LDA     0,0             ; "   LOC 0
00021'040413            STA     0,CLSV+1
                ;
00022'010006$           ISZ     INTER
00023'010007$           ISZ     CTDWN
00024'010010$           ISZ     RTIME
                ;RETURN
00025'020407            LDA     0,CLSV+1
00026'040000            STA     0,0
00027'020404            LDA     0,CLSV
00030'060114            NIOS    RTC
00031'060177            INTEN
00032'002000            JMP@    0
                ;
00033'000000    CLSV:   0
00034'000000            0
00035'000000    CSPAR:  0
      000050            CRI=50
                ;CRT ROUTINE
                ;
00036'020777    SRCRT:  LDA     0,CSPAR
00037'040426            STA     0,TINT  ;SAVE AC0
00040'020000            LDA     0,0     ; "   LOC 0
00041'040425            STA     0,TINT+1
```

```
00042'044425            STA     1,TINT+2
00043'063650            SKPDN   CRI
00044'000777            JMP     .-1
00045'060650            DIAC    0,CRI
00046'024416            LDA     1,PMSK
00047'123400            AND 1,0         ;STPIP PARITY BIT
00050'040005$           STA     0,RESP
00051'020010$           LDA     0,RTIME
00052'040004$           STA     0,TTIME
                ;
00053'020003$ DLIV:     LDA     0,CLMSK ;PTC INT ONLY
00054'062077            MSKO    0
00055'020411            LDA     0,TINT+1
00056'024411            LDA 1,TINT+2
00057'040000            STA     0,0
00060'020405            LDA     0,TINT
00061'060114            NIOS    RTC
00062'060177            INTEN
00063'002000            JMP@    0
                ;
00064'000177  PMSK:     177
      000004  TINT:     .BLK 4
                ;
                ;ERROR ROUTINE
00071'020406  IOER:     LDA     0,ACAUS
00072'101120            MOVZL   0,0
00073'040402            STA     0,.+2
00074'006002$           JSR@    AOUTP
00075'000000            0
00076'002001$           JMP@    ARAP
00077'000100' ACAUS:    CAUS
                ;
00100'005015  CAUS:     .TXT*<15><12>
00101'044412  <12>I
00102'052116  NT
00103'051105  ER
00104'052522  RU
00105'052120  PT
00106'042440   E
00107'051122  RR
00110'051117  OR
00111'000040   *
                ;
                ; TELETYPE ROUTINE
00112'020406  TELE:     LDA     0,ATELE
00113'101120            MOVZL   0,0
00114'040402            STA     0,.+2
00115'006002$           JSR     @AOUTP
00116'000000            0
00117'002001$           JMP     @ARAP
00120'000121' ATELE:    TELEX

00121'006440  TELEX:    .TXT * <15>
00122'005012  <12><12>
00123'042524  TE
00124'042514  LE
00125'054524  TY
00126'042520  PE
00127'044440   I
00130'052116  NT
```

```
00131'051105  ER
00132'052522  RU
00133'052120  PT
00134'026440   -
00135'020055  -
00136'052522  RU
00137'020116  N
00140'051511  IS
00141'040440   A
00142'047502  BO
00143'052122  RT
00144'042105  ED
00145'000040   *

                      .ZREL
00000-000000' ARTUP:  INRUP
              ;
                      .END
```

```
                ;SUBROUTINE SCORE -- STORES INFORMATION DURING
                ;REACTION TIME EXPERIMENT FOR LATER ANALYSIS.
                ;KEEPS TRACK OF WHICH TRIALS NEED TO BE RERUN
                ;AT END OF REGULAR SEQUENCE.
                ;ENTRY:    JSR @ASCOR
                ;(AC0) ON ENTRY WILL BE FOLLOWING CODE:
                ;       1 = CORRECT RESPONSE
                ;       2 = ERROR RESPONSE
                ;       3 = NULL (MIN,MAX TIME LIMITS)
                ;OVINC IS SET TO ZERO BY SUBROUTINE DESIGN
                ;FOR EACH NEW RUN.  REPC, WHICH IS AN
                ;INDICATOR FOR HOW TO HANDLE ERRORS AND
                ;NULLS, IS SET IN DESIGN.  1 = RERUN ALL
                ;ERRORS AND NULLS, 2 = THROW THEM OUT.
                ;NOTE:  BUILDS TABLES IN A TOP-TO-BOTTOM
                ;ORDER, CONSISTENT WITH SUBROUTINES
                ;DESIGN AND RTANL.
                ;
                ;       G.M.OLSON
                ;       9 NOVEMBER 1972 (A)

                        .TITL SCORE
                        .ENT ASCOR,ACODE,ATIME,AOVER,OVINC,REPC
                        .EXTD CTRLS,RTIME,NOVER

                        .ZREL
00000-000000' ASCOR:    START
00001-000027' ACODE:    CODE-1
00002-000427' ATIME:    TIME-1
00003-001027' AOVER:    OVER-1
00004-000000  OVINC:    0
00005-000000  REPC:     0

                        .NREL
00000'054426  START:    STA 3,ONYX          ;SAVE RETURN
00001'024001$           LDA 1,CTRLS         ;GET TRIAL CT
00002'030001-           LDA 2,ACODE         ;ADDR. OF CODE ARRAY
00003'133000            ADD 1,2
00004'041000            STA 0,0,2           ;STORE CODE
00005'030002-           LDA 2,ATIME         ;ADDR. OF TIME ARRAY
00006'133000            ADD 1,2
00007'034002$           LDA 3,RTIME
00010'055000            STA 3,0,2           ;STORE TIME
00011'030416            LDA 2,ONES
00012'112415            SUB# 0,2,SNR
00013'002413            JMP @ONYX
00014'020005- NULL:     LDA 0,REPC          ;CHECK FOR RERUN OPTION
00015'101233            MOVZR# 0,0,SNC
00016'002410            JMP @ONYX           ;NO RERUN
00017'010004-           ISZ OVINC           ;ADD TO RERUN CT
00020'010003$           ISZ NOVER           ;INCREMENT TEMP. RERUN CT
00021'030003-           LDA 2,AOVER         ;ADDRESS OF RERUN ARRAY
00022'020004-           LDA 0,OVINC
00023'113000            ADD 0,2
00024'045000            STA 1,0,2           ;STORE CURRENT TRIAL CT
00025'002401            JMP @ONYX

00026'000000  ONYX:     0
```

```
00027'000001  ONES:    1
       000400  CODE:    .BLK 400
       000400  TIME:    .BLK 400
       000200  OVER:    .BLK 200
                        .END
```

```
                        ;SUBROUTINE FOR DESIGN OF RT EXPERIMENTS
                        ;       QUERIES "E" FOR DESIGN PARAMETERS
                        ;       SETS UP SET OF TRIALS FOR RUN
                        ;       FETCHES VALUES OF STIMULI AND
                        ;       FOREPERIODS DURING RUN
                        ;CALLS:
                        ;       JSR @ABEGIN     FOR INITIAL DESIGN
                        ;                       OR RUN SETUP
                        ;       JSR @AFORE      TO FETCH FOREPERIOD
                        ;                       --RETURNED IN LOC. FP
                        ;       JSR @ASTIM      TO FETCH STIMULUS CODE
                        ;                       --RETURNED IN LOC. CS
                        ;                       --CORRECT RESPONSE CODE
                        ;                       --RETURNED IN LOC. CRESP
                        ;REQUIRES SUBROUTINES PERMUTE, BMAN, & INOUT
                        ;USES ALL ACCUMULATORS DESTRUCTIVELY
                        ;SAVES CONTENTS OF LOCS 20-25
                        ;ASSUMES:
                        ;       1.  STIMULI AND RESPONSES ARE REPRESENTE
                        ;       BY NUMERIC CODES WHICH WILL BE PASSED TO
                        ;       A STIMULUS GENERATION SUBROUTINE AT RUN
                        ;       TIME
                        ;       2.  ALL NUMERIC INPUTS DURING
                        ;       QUERIES ARE DECIMAL
                        ;       3.  MAX VALUES ARE:
                        ;               # STIMULI = 64
                        ;               # RESPONSES = 64
                        ;               # FOREPERIODS = 16
                        ;               # TRIALS = 256
                        ;       4.  BLOCKING FACTOR WILL BE USED
                        ;       TO DETERMINE THE MANNER IN WHICH
                        ;       THE INDIVIDUAL RUNS WILL BE RANDOMIZED
                        ;
                        ;               G.M.OLSON
                        ;               19 MARCH 1973  (A)

                        .TITL DESIGN
                        .ENT ABEGIN,AFORE,ASTIM,AFP,ACS,ARESP
                        .ENT ISTIM,IFORE,ATYPE,APE
                        .EXTD AOUTP,ADCEN,AGETC,ABNDC,APRMT
                        .EXTD EXP,SUBJ,GROUP,TRLS,ITI,MAX,MIN
                        .EXTD FP,CT,CS,CTRLS,NFP,OLD,ARAND
                        .EXTD CRESP,OVINC,REPC


                        .ZREL
00000-000000' ABEGIN:   BEGIN
00001-000050' AFORE:    EWR
00002-000060' ASTIM:    LGA
00003-002577' IFORE:    FORE-1
00004-002177' ISTIM:    STIM-1
00005-001177' ISPACE:   SPACE-1
00006-001577' IPLACE:   PLACE-1
00007-003177' AFP:      FPTAB-1
00010-003217' ACS:      CSTAB-1
00011-003317' ARESP:    RTAB-1
      000010  SAVE:     .BLK 10
      000010  WORK:     .BLK 10
```

```
00032-001024' ARRANGE: PUNT
00033-000001  ONE:     1
00034-000000  ZERO:    0
00035-000000  BLK:     0
00036-000256' ATYPE:   PRINT
00037-000264' APE:     PGET
00040-000270' ATXT:    TXT1
00041-000302'          TXT2
00042-000317'          TXT3
00043-000346'          TXT4
00044-000367'          TXT5
00045-000403'          TXT6
00046-000416'          TXT7
00047-000433'          TXT8
00050-000441'          TXT9
00051-000451'          TXT10
00052-000461'          TXT11
00053-000500'          TXT12
00054-000516'          TXT13
00055-000534'          TXT14
00056-000572'          TXT15
00057-000621'          TXT16
00060-000651'          TXT17
00061-000677'          TXT18
00062-000711'          TXT19
00063-000713'          TXT20
00064-000714'          TXT21
00065-000744'          TXT22
00066-000773'          TXT23
00067-001006'          TXT24

                       .NREL
00000'054012- BEGIN:   STA 3,SAVE        ;SAVE (AC3)
00001'020040-          LDA 0,ATXT        ;PRINT HEADING
00002'006036-          JSR @ATYPE
00003'020064-          LDA 0,ATXT+24
00004'006036-          JSR @ATYPE
00005'020041- WHY:     LDA 0,ATXT+1      ;EXP #
00006'006037-          JSR @APE
00007'044440           STA 1,TEXP        ;TEMP. EXP. NO.
00010'020006$          LDA 0,EXP
00011'106415           SUB# 0,1,SNR      ;CHECK VS. OLD EXP #
00012'000402           JMP .+2
00013'004475           JSR CHANGE        ;EXP #S DO NOT MATCH
00014'020044-          LDA 0,ATXT+4      ;SUBJ #
00015'006037-          JSR @APE
00016'044007$          STA 1,SUBJ
00017'020045-          LDA 0,ATXT+5      ;GROUP #
00020'006037-          JSR @APE
00021'044010$          STA 1,GROUP
00022'024007$          LDA 1,SUBJ        ;ROUTINE TO SET
00023'030006$          LDA 2,EXP         ;RANDOM NUMBER
00024'133000           ADD 1,2           ;GENERATOR SEED
00025'150000           COM 2,2
00026'024416           LDA 1,RMSK
00027'133400           AND 1,2
00030'020416           LDA 0,RCON
00031'113000           ADD 0,2
00032'021005           LDA 0,5,2
00033'040022$          STA 0,OLD
```

```
00034'107400            AND 0,1
00035'044410            STA 1,MCT
00036'006023$           JSR @ARAND
00037'000022$           OLD
00040'014405            DSZ MCT
00041'000775            JMP .-3
00042'006032-           JSR @APRANGE    ;SET UP RAN
00043'002012-           JMP @SAVE       ;RETURN
00044'000077  PMSK:     000077
00045'000000  MCT:      0
00046'000400  RCON:     400
00047'000000  TEXP:     0

00050'054012- EWR:      STA 3,SAVE      ;SAVE (AC3)
00051'010012-           ISZ SAVE        ;INC. PC FOR RETURN
00052'030003-           LDA 2,IFORE     ;ADDRESS OF FOREPERIOD ARRAY
00053'024020$           LDA 1,CTRLS     ;CURRENT TRIAL #
00054'133000            ADD 1,2         ;GENERATE NEW ADDRESS
00055'025000            LDA 1,0,2       ;(AC1) = FOREPERIOD
00056'044015$           STA 1,FP        ;STORE IT
00057'002012-           JMP @SAVE       ;RETURN
00060'054012- LGA:      STA 3,SAVE      ;SAVE (AC3)
00061'030004-           LDA 2,ISTIM     ;ADDRESS OF STIMULUS ARRAY
00062'024020$           LDA 1,CTRLS     ;CURRENT TRIAL #
00063'133000            ADD 1,2         ;GENERATE NEW ADDRESS
00064'025000            LDA 1,0,2       ;(AC1) = STIMULUS CODE
00065'044017$           STA 1,CS        ;STORE IT
00066'020020            LDA 0,20        ;SAVE (20)
00067'040013-           STA 0,SAVE+1
00070'020034-           LDA 0,ZERO      ;ZERO COUNTER
00071'040022-           STA 0,WORK
00072'020010-           LDA 0,ACS       ;ADDR. OF STIM. TABLE
00073'040020            STA 0,20
00074'010022-           ISZ WORK        ;INCR. COUNT
00075'022020            LDA 0,@20
00076'106414            SUB# 0,1,SZR    ;CHECK IF STIM. MATCH
00077'000775            JMP .-3
00100'030011-           LDA 2,ARESP     ;ADDR. OF RESP. TABLE
00101'020022-           LDA 0,WORK      ;COUNT OF STIM. POSITION
00102'113000            ADD 0,2         ;CREATE ADDR. OF COR. RESP. CODE
00103'021000            LDA 0,0,2       ;FETCH CORRECT RESP. CODE
00104'040024$           STA 0,CRESP     ;STORE IT
00105'020013-           LDA 0,SAVE+1    ;RESTORE (20)
00106'040020            STA 0,20
00107'002012-           JMP @SAVE


00110'054013- CHANGE:   STA 3,SAVE+1
00111'020042-           LDA 0,ATXT+2    ;QUERY RE DESIGN CHANGE
00112'006037-           JSR @APE
00113'020033-           LDA 0,ONE       ;CHECK FOR "NO"
00114'106415            SUB# 0,1,SNR
00115'000402            JMP .+2         ;IF "NO"
00116'000411            JMP BOS         ;IF "YES"
00117'020043-           LDA 0,ATXT+3    ;CHECK FOR CODE CHANGE
00120'006037-           JSR @APE
00121'020033-           LDA 0,ONE       ;CHECK FOR "NO"
00122'106415            SUB# 0,1,SNR
00123'000662            JMP WHY         ;IF "NO"
00124'020723            LDA 0,TEXP      ;IF "YES"
```

```
00125'040006$           STA 0,EXP
00126'002013-           JMP @SAVE+1
00127'020056- BOS:      LDA 0,ATXT+16   ;MESSAGE
00130'006036-           JSR @ATYPE
00131'020057-           LDA 0,ATXT+17
00132'006036-           JSR @ATYPE
00133'020060-           LDA 0,ATXT+20
00134'006036-           JSR @ATYPE
00135'020712            LDA 0,TEXP
00136'040006$           STA 0,EXP
00137'020046-           LDA 0,ATXT+6    ;# TRIALS
00140'006037-           JSR @APE
00141'044011$           STA 1,TRLS
00142'020061-           LDA 0,ATXT+21
00143'006037-           JSR @APE
00144'044035-           STA 1,BLK
00145'020047-           LDA 0,ATXT+7
00146'006037-           JSR @APE        ;ITI
00147'044012$           STA 1,ITI
00150'020050-           LDA 0,ATXT+10   ;MAX RT
00151'006037-           JSR @APE
00152'044013$           STA 1,MAX
00153'020051-           LDA 0,ATXT+11   ;MIN RT
00154'006037-           JSR @APE
00155'044014$           STA 1,MIN
00156'024020            LDA 1,20        ;SAVE (20)
00157'044023-           STA 1,WORK+1
00160'024021            LDA 1,21
00161'044024-           STA 1,WORK+2
00162'020052-           LDA 0,ATXT+12   ;# FOREPERIODS
00163'006037-           JSR @APE
00164'044021$           STA 1,NFP
00165'044025-           STA 1,WORK+3
00166'010025-           ISZ WORK+3
00167'020053-           LDA 0,ATXT+13
00170'006036-           JSR @ATYPE
00171'024007-           LDA 1,AFP       ;ADDRESS OF FP TABLE
00172'044020            STA 1,20        ;LOC 20 = AFP
00173'024034-           LDA 1,ZERO
00174'044022-           STA 1,WORK      ;SET PRINT AT 0
00175'010022- ORD:      ISZ WORK        ;INCREMENT PRINT NO.
00176'014025-           DSZ WORK+3      ;DECREMENT STEP CT
00177'000402            JMP .+2         ;GO TO FP REQ PRINT
00200'000410            JMP MSP         ;SKIP IF DONE
00201'024022-           LDA 1,WORK
00202'006004$           JSR @ABNDC      ;PRINT FP NO.
00203'020063-           LDA 0,ATXT+23   ;SPACE
00204'006036-           JSR @ATYPE
00205'006002$           JSR @ADCBN      ;GET FP VALUE
00206'046020            STA @1,20       ;STORE FP VALUE
00207'000766            JMP ORD         ;LOOP
00210'020054- MSP:      LDA 0,ATXT+14   ;# STIMULI
00211'006037-           JSR @APE
00212'044016$           STA 1,CT
00213'044025-           STA 1,WORK+3
00214'010025-           ISZ WORK+3
00215'020055-           LDA 0,ATXT+15
00216'006036-           JSR @ATYPE
00217'024034-           LDA 1,ZERO
00220'044022-           STA 1,WORK
```

```
00221'024010-           LDA 1,ACS       ;ADDRESS OF STIM TABLE
00222'044020            STA 1,20
00223'024011-           LDA 1,ARESP     ;ADDRESS OF RESP TABLE
00224'044021            STA 1,21
00225'010022- OAK:      ISZ WORK
00226'014025-           DSZ WORK+3
00227'000402            JMP .+2
00230'000416            JMP SLC
00231'024022-           LDA 1,WORK
00232'006004$           JSR @ABNDC      ;PRINT STIM NO.
00233'020066-           LDA 0,ATXT+26
00234'006036-           JSR @ATYPE
00235'006002$           JSR @ADCBN      ;GET, STORE STIM CODE
00236'046020            STA @1,20
00237'020067-           LDA 0,ATXT+27
00240'006036-           JSR @ATYPE
00241'006002$           JSR @ADCBN      ;GET,STORE CORRECT RESP CODE
00242'046021            STA @1,21
00243'020062-           LDA 0,ATXT+22   ;CR AND LF
00244'006036-           JSR @ATYPE
00245'000760            JMP OAK
00246'020065- SLC:      LDA 0,ATXT+25   ;QUERY RE NULLS & ERRORS
00247'006037-           JSR @APE
00250'044026$           STA 1,PEPC
00251'024023-           LDA 1,WORK+1    ;PESTORE (20)
00252'044020            STA 1,20
00253'024024-           LDA 1,WORK+2    ;PESTORE (21)
00254'044021            STA 1,21
00255'002013-           JMP @SAVE+1
00256'054014- PRINT:    STA 3,SAVE+2
00257'101120            MOVZL 0,0
00260'040402            STA 0,JFK
00261'006001$           JSR @AOUTP
00262'000000 JFK:       0
00263'002014-           JMP @SAVE+2
00264'054015- PGET:     STA 3,SAVE+3
00265'006036-           JSR @ATYPE
00266'006002$           JSR @ADCBN
00267'002015-           JMP @SAVE+3


00270'005015 TXT1:      .TXT *<15><12>
00271'020012 <12>
00272'052122 RT
00273'042440  E
00274'050130 XP
00275'050040  P
00276'047522 RO
00277'051107 GR
00300'046501 AM
00301'000040  *
00302'005015 TXT2:      .TXT *<15><12>
00303'020012 <12>
00304'054105 EX
00305'042520 PE
00306'044522 RI
00307'042515 ME
00310'052116 NT
00311'041440  C
00312'042117 OD
```

```
00313'020105  E
00314'020075  =
00315'020077  ?
00316'000000  *
00317'005015  TXT3:    .TXT *<15><12>
00320'020012  <12>
00321'042516  NE
00322'020127  W
00323'047503  CO
00324'042504  DE
00325'020056  .
00326'041440   C
00327'040510  HA
00330'043516  NG
00331'020105  E
00332'042504  DE
00333'044523  SI
00334'047107  GN
00335'020077  ?
00336'030450  (1
00337'020051  )
00340'047516  NO
00341'024040   (
00342'024462  2)
00343'054440   Y
00344'051505  ES
00345'000040   *
00346'005015  TXT4:    .TXT *<15><12>
00347'020012  <12>
00350'044103  CH
00351'047101  AN
00352'042507  GE
00353'041440   C
00354'042117  OD
00355'037505  E?
00356'024040   (
00357'024461  1)
00360'047040   N
00361'020117  O
00362'031050  (2
00363'020051  )
00364'042531  YE
00365'020123  S
00366'000000  *
00367'005015  TXT5:    .TXT *<15><12>
00370'020012  <12>
00371'052523  SU
00372'045102  BJ
00373'041505  EC
00374'020124  T
00375'052516  NU
00376'041115  MB
00377'051105  ER
00400'036440   =
00401'037440   ?
00402'000040   *
00403'005015  TXT6:    .TXT *<15><12>
00404'043440   G
00405'047522  RO
00406'050125  UP
```

```
00407'047040   N
00410'046525  UM
00411'042502  BE
00412'020122  R
00413'020075  =
00414'020077  ?
00415'000000  *
00416'005015  TXT7:    .TXT *<15><12>
00417'047040   N
00420'046525  UM
00421'042502  BE
00422'020122  R
00423'043117  OF
00424'052040   T
00425'044522  RI
00426'046101  AL
00427'020123  S
00430'020075  =
00431'020077  ?
00432'000000  *
00433'005015  TXT8:    .TXT *<15><12>
00434'044440   I
00435'044524  TI
00436'036440   =
00437'037440   ?
00440'000040   *
00441'005015  TXT9:    .TXT *<15><12>
00442'046440   M
00443'054101  AX
00444'051040   R
00445'020124  T
00446'020075  =
00447'020077  ?
00450'000000  *
00451'005015  TXT10:   .TXT *<15><12>
00452'046440   M
00453'047111  IN
00454'051040   P
00455'020124  T
00456'020075  =
00457'020077  ?
00460'000000  *
00461'005015  TXT11:   .TXT *<15><12>
00462'047040   N
00463'046525  UM
00464'042502  BE
00465'020122  R
00466'043117  OF
00467'043040   F
00470'051117  OR
00471'050105  EP
00472'051105  ER
00473'047511  IO
00474'051504  DS
00475'036440   =
00476'037440   ?
00477'000040   *
00500'005015  TXT12:   .TXT *<15><12>
00501'043040   F
00502'051117  OR
```

```
00503'050105  EP
00504'051105  ER
00505'047511  IO
00506'051504  DS
00507'044440   I
00510'020116  N
00511'051515  MS
00512'041505  EC
00513'020056  .
00514'005015  <15><12>
00515'000000  *
00516'005015  TXT13:   .TXT *<15><12>
00517'020012  <12>
00520'052516  NU
00521'041115  MB
00522'051105  ER
00523'047440   O
00524'020106  F
00525'052123  ST
00526'046511  IM
00527'046125  UL
00530'020111  I
00531'020075  =
00532'020077  ?
00533'000000  *
00534'005015  TXT14:   .TXT*<15><12>
00535'052040   T
00536'050131  YP
00537'020105  E
00540'052123  ST
00541'046511  IM
00542'046125  UL
00543'051525  US
00544'041440   C
00545'042117  OD
00546'020105  E
00547'047506  FO
00550'046114  LL
00551'053517  OW
00552'042105  ED
00553'041040   B
00554'020131  Y
00555'047503  CO
00556'051122  RR
00557'041505  EC
00560'020124  T
00561'042522  RE
00562'050123  SP
00563'047117  ON
00564'042523  SE
00565'041440   C
00566'042117  OD
00567'020105  E
00570'005015  <15><12>
00571'000000  *
00572'005015  TXT15:   .TXT *<15><12>
00573'041040   B
00574'047514  LO
00575'045503  CK
00576'051440   S
```

```
00577'055111  IZ
00600'020105  E
00601'052515  MU
00602'052123  ST
00603'042440   E
00604'052521  QU
00605'046101  AL
00606'047040   N
00607'021450  (#
00610'052123  ST
00611'046511  IM
00612'024051  )(
00613'043043  #F
00614'024520  P)
00615'020054  ,
00616'044127  WH
00617'051105  ER
00620'000105  E*
00621'005015  TXT16:   .TXT *<15><12>
00622'047040   N
00623'044440   I
00624'020123  S
00625'047101  AN
00626'044440   I
00627'052116  NT
00630'043505  EG
00631'051105  ER
00632'037040   >
00633'030040   0
00634'020056  .
00635'041040   B
00636'047514  LO
00637'045503  CK
00640'051440   S
00641'055111  IZ
00642'020105  E
00643'052515  MU
00644'052123  ST
00645'040440   A
00646'051514  LS
00647'020117  O
00650'000000  *
00651'005015  TXT17:   .TXT *<15><12>
00652'041040   B
00653'020105  E
00654'047101  AN
00655'044440   I
00656'052116  NT
00657'043505  EG
00660'040522  RA
00661'020114  L
00662'052521  QU
00663'052117  OT
00664'042511  IE
00665'052116  NT
00666'047440   O
00667'020106  F
00670'020043  #
00671'051124  TR
00672'040511  IA
```

```
00673'051514  LS
00674'020056  .
00675'005015  <15><12>
00676'000000  *
00677'005015  TXT18:   .TXT *<15><12>
00700'041040   B
00701'047514  LO
00702'045503  CK
00703'051440   S
00704'055111  IZ
00705'020105  E
00706'020075  =
00707'020077  ?
00710'000000  *
00711'005015  TXT19:   .TXT *<15><12>
00712'000000  *
00713'000040  TXT20:   .TXT *<40>*
00714'005015  TXT21:   .TXT *<15><12>
00715'040440   A
00716'046114  LL
00717'042440   E
00720'052116  NT
00721'044522  RI
00722'051505  ES
00723'040440   A
00724'042522  RE
00725'042040   D
00726'041505  EC
00727'046511  IM
00730'046101  AL
00731'020054  ,
00732'046101  AL
00733'020114  L
00734'044524  TI
00735'042515  ME
00736'020123  S
00737'047111  IN
00740'046440   M
00741'042523  SE
00742'027103  C.
00743'000000  *
00744'005015  TXT22:   .TXT *<15><12>
00745'051040   R
00746'051105  ER
00747'047125  UN
00750'042440   E
00751'051122  RR
00752'051117  OR
00753'020123  S
00754'020046  &
00755'052516  NU
00756'046114  LL
00757'020123  S
00760'030450  (1
00761'020051  )
00762'051117  OR
00763'042040   D
00764'051511  IS
00765'040503  CA
00766'042122  RD
```

```
00767'024040   (
00770'024462  2)
00771'020077  ?
00772'000000  *
00773'020040  TXT23:   .TXT *
00774'020040
00775'052123  ST
00776'046511  IM
00777'046125  UL
01000'051525  US
01001'041440   C
01002'042117  OD
01003'020105  E
01004'020075  =
01005'000040   *
01006'020040  TXT24:   .TXT *
01007'020040
01010'020040
01011'020040
01012'051040   R
01013'051505  ES
01014'047520  PO
01015'051516  NS
01016'020105  E
01017'047503  CO
01020'042504  DE
01021'036440   =
01022'020040
01023'000000  *

01024'054014- PUNT:    STA 3,SAVE+2     ;SAVE (AC3)
01025'030011$          LDA 2,TRLS       ;# TRIALS
01026'050022-          STA 2,WORK
01027'030020           LDA 2,20         ;SAVE (20)
01030'050015-          STA 2,SAVE+3
01031'030021           LDA 2,21         ;SAVE (21)
01032'050016-          STA 2,SAVE+4
01033'030022           LDA 2,22         ;SAVE (22)
01034'050017-          STA 2,SAVE+5
01035'030023           LDA 2,23         ;SAVE (23)
01036'050020-          STA 2,SAVE+6
01037'030024           LDA 2,24         ;SAVE (24)
01040'050021-          STA 2,SAVE+7
01041'030004-          LDA 2,ISTIM      ;ADDRESS OF STIM ARRAY
01042'050020           STA 2,20
01043'030005-          LDA 2,ISPACE     ;ADDRESS OF SPACE
01044'050021           STA 2,21
01045'030006-          LDA 2,IPLACE     ;ADDRESS OF PLACE
01046'050022           STA 2,22
01047'152400           SUB 2,2          ;(AC2) = 0
01050'050031-          STA 2,WORK+7     ;FP INDICATOR = 0
01051'020525  AUDI:    LDA 0,CHK        ;CHECK STIM
01052'113404           AND 0,2,SZR      ;INDICATOR
01053'000423           JMP FORD         ;NOT FINISHED
01054'020016$          LDA 0,CT         ;RESET FOR NEW BLOCK
01055'040023-          STA 0,WORK+1
01056'020010-          LDA 0,ACS
01057'040023           STA 0,23
01060'020516           LDA 0,CHK        ;CHECK FP IND
01061'024031-          LDA 1,WORK+7
```

```
01062'107404            AND 0,1,SZP
01063'000405            JMP .+5
01064'020021$           LDA 0,NFP
01065'040024-           STA 0,WORK+2
01066'020007-           LDA 0,AFP
01067'040024            STA 0,24
01070'026024            LDA @1,24
01071'044030-           STA 1,WORK+6
01072'176400            SUB 3,3
01073'014024-           DSZ WORK+2          ;CHECK IF THROUGH
01074'034033-           LDA 3,ONE           ;FOREPERIODS
01075'054031-           STA 3,WORK+7
01076'026023  FORD:     LDA @1,23           ;GET STIM FROM TABLE
01077'046021            STA @1,21           ;STORE STIM IN SPACE
01100'024030-           LDA 1,WORK+6        ;GET CURRENT FP
01101'046022            STA @1,22           ;STORE FP IN PLACE
01102'030021            LDA 2,21            ;STORE CURRENT ADDRESS
01103'052020            STA @2,20           ;OF SPACE IN STIM ARRAY
01104'014022-           DSZ WORK            ;CHECK TRIAL COUNT
01105'000402            JMP .+2
01106'000405            JMP MIX             ;GO TO MIX IF DONE
01107'152400            SUB 2,2
01110'014023-           DSZ WORK+1          ;CHECK STIM COUNT
01111'030033-           LDA 2,ONE           ;SET INDICATOR TO ONE
01112'000737            JMP AUDI
01113'102400  MIX:      SUB 0,0
01114'040022-           STA 0,WORK          ;ZERO TRIAL COUNT
01115'020035-           LDA 0,BLK           ;BLOCK SIZE
01116'040406            STA 0,SIZE          ;SET PERMUTATION PARAMETER
01117'024004-           LDA 1,ISTIM         ;SET PERMUTATION START
01120'125400            INC 1,1
01121'044402            STA 1,PARIS         ;ADDRESS
01122'006005$ RMIX:     JSR @APRMT          ;CALL PERMUTE
01123'000000  PARIS:    0
01124'000000  SIZE:     0
01125'020035-           LDA 0,BLK
01126'024022-           LDA 1,WORK
01127'107000            ADD 0,1             ;INCREMENT TRIAL COUNT
01130'044022-           STA 1,WORK
01131'030011$           LDA 2,TRLS
01132'132405            SUB 1,2,SNR         ;CHECK IF DONE
01133'000406            JMP TRANS           ;TO COPY
01134'020767            LDA 0,PARIS         ;SET UP FOR NEXT
01135'024035-           LDA 1,BLK           ;PERMUTATION
01136'123000            ADD 1,0
01137'040764            STA 0,PARIS
01140'000762            JMP RMIX
01141'020011$ TRANS:    LDA 0,TRLS          ;SET UP COUNT
01142'040022-           STA 0,WORK
01143'020004-           LDA 0,ISTIM         ;ADDRESS OF STIM APRAY
01144'040020            STA 0,20
01145'020003-           LDA 0,IFORE         ;ADDRESS OF FP ARRAY
01146'040021            STA 0,21
01147'032020  SFO:      LDA @2,20           ;GET ADDRESS STORED
01150'014020            DSZ 20              ;CURRENTLY IN STIM ARRAY
01151'025000            LDA 1,0,2           ;LOAD AC1 FROM SPACE
01152'046020            STA @1,20           ;STORE IN STIM ARRAY
01153'020424            LDA 0,ACON          ;GET CONSTANT
01154'113000            ADD 0,2             ;CREATE NEW ADDRESS
01155'025000            LDA 1,0,2           ;LOAD AC1 FROM PLACE
```

```
01156'046021            STA @1,21       ;STORE IN FORE ARRAY
01157'014022-           DSZ WORK        ;CHECK IF DONE
01160'000767            JMP SFO
01161'030034-           LDA 2,ZERO      ;ZERO REGISTER OVINC
01162'050025$           STA 2,OVINC
01163'030015-           LDA 2,SAVE+3
01164'050020            STA 2,20        ;RESTORE (20)
01165'030016-           LDA 2,SAVE+4
01166'050021            STA 2,21        ;RESTORE (21)
01167'030017-           LDA 2,SAVE+5
01170'050022            STA 2,22        ;RESTORE (22)
01171'030020-           LDA 2,SAVE+6
01172'050023            STA 2,23        ;RESTORE (23)
01173'030021-           LDA 2,SAVE+7
01174'050024            STA 2,24        ;RESTORE (24)
01175'002014-           JMP @SAVE+2
01176'177777  CHK:      177777
01177'000400  ACON:     400

       000400  SPACE:   .BLK 400
       000400  PLACE:   .BLK 400
       000400  STIM:    .BLK 400
       000400  FORE:    .BLK 400
       000020  FPTAB:   .BLK 20
       000100  CSTAB:   .BLK 100
       000100  RTAB:    .BLK 100
                        .END
```

```
                        .TITL MTAPE
                        .ENT AWERB
                        .EXTD EXP,SUBJ,GROUP,TRLS,CT,NFP
                        .EXTD REPC,ISTIM,IFOPE,ACODE,ATIME
                        .EXTD AEOF

                ;       SUBROUTINE TO DUMP RT DATA ONTO TAPE
                ;
                ;
                ;       G.M. OLSON
                ;       11 DECEMBER 1972 (A)

      102113            .DALC   SGE=ADCL# 0,0,SNC

                        .ZREL
00000-000200' AWD:      WD
00001-000204' ATB:      TENDC
00002-000000' AWERB:    START
00003-000120' ASR:      ISR

                        .NREL

00000'054556  START:    STA 3,SWAV      ;SAVE RETURN


00001'060474            DIA 0,74        ;GET READY BIT
00002'101100            MOVL 0,0
00003'101113            MOVL# 0,0,SNC   ;READY?
00004'000775            JMP .-3         ;WAIT

00005'004467            JSR LZERO       ;WRITE LEADING 0
00006'024001$           LDA 1,EXP       ;WRITE EXP. NO.
00007'006001-           JSR @ATB
00010'004464            JSR LZERO
00011'024002$           LDA 1,SUBJ      ;WRITE SUBJ. NO.
00012'006001-           JSR @ATB
00013'004461            JSR LZERO
00014'024003$           LDA 1,GROUP     ;WRITE GROUP NO.
00015'006001-           JSR @ATB
00016'004456            JSR LZERO
00017'024004$           LDA 1,TRLS      ;WRITE NO. TRIALS
00020'006001-           JSR @ATB
00021'004453            JSR LZERO
00022'024005$           LDA 1,CT        ;WRITE NO. STIMULI
00023'006001-           JSR @ATB
00024'004450            JSR LZERO
00025'024006$           LDA 1,NFP       ;WRITE NO. FOREPERIODS
00026'006001-           JSR @ATB
00027'004445            JSR LZERO
00030'024007$           LDA 1,REPC      ;WRITE ERROR CODE
00031'006001-           JSR @ATB
00032'020477            LDA 0,BIG
00033'040537            STA 0,WORK+5
00034'004440  MORE:     JSR LZERO
00035'024471            LDA 1,ZERO
00036'006001-           JSR @ATB
00037'014533            DSZ WORK+5
00040'000774            JMP MORE
```

```
00041'004437            JSR STALL
00042'020533            LDA 0,IRG       ;WRITE IRG
00043'062074            DOB 0,74
00044'004434            JSR STALL
00045'020010$ TSTM:     LDA 0,ISTIM     ;STORE STIM
00046'040402            STA 0,.+2
00047'004463            JSR PPEP
00050'000000            0
00051'004472            JSR TAPE
00052'020011$ TFP:      LDA 0,IFORE     ;STORE FOREPERIODS
00053'040402            STA 0,.+2
00054'004456            JSR PREP
00055'000000            0
00056'004465            JSR TAPE
00057'020012$ TCD:      LDA 0,ACODE     ;STORE CODES
00060'040402            STA 0,.+2
00061'004451            JSR PREP
00062'000000            0
00063'004460            JSR TAPE
00064'020013$ TTM:      LDA 0,ATIME     ;STORE REACTION TIMES
00065'040402            STA 0,.+2
00066'004444            JSR PREP
00067'000000            0
00070'004453            JSR TAPE

00071'006014$           JSR @AEOF       ;WRITE EOF
00072'000001            1
00073'002463            JMP @SWAV
00074'054464 LZERO:     STA 3,SWAV+2    ;ROUTINE TO WRITE LEADING 0S
00075'020501            LDA 0,C60
00076'006000-           JSR @AWD
00077'002461            JMP @SWAV+2
00100'054461 STALL:     STA 3,SWAV+3    ;STORE RETURN
00101'020003-           LDA 0,ASR       ;STORE ISR IN LOC 1
00102'040001            STA 0,1
00103'020423            LDA 0,ZERO      ;SET COUNT TO 0
00104'040423            STA 0,COUNT
00105'020420            LDA 0,CLMSK     ;SET CLOCK INTERRUPT
00106'062177            DOBS 0,CPU
00107'020415            LDA 0,CLKFQ     ;SET CLOCK TICKING
00110'061114            DOAS 0,RTC
00111'024417            LDA 1,CONS      ;SET CHECK VALUE
00112'020415            LDA 0,COUNT
00113'106113            SGE 0,1         ;INTERVAL OVER?
00114'000776            JMP .-2
00115'060277            INTDS
00116'060214            NIOC RTC
00117'002442            JMP @SWAV+3
00120'010407 ISR:       ISZ COUNT
00121'060114            NIOS RTC
00122'060177            INTEN
00123'002000            JMP @0
00124'000001 CLKFQ:     1
00125'177773 CLMSK:     177773
00126'000000 ZERO:      0
00127'000000 COUNT:     0
00130'000050 CONS:      50
00131'000030 BIG:       30
             ;
             ;ROUTINE TO SET UP TRANSFER TO TAPE
```

```
00132'054425  PREP:   STA 3,SWAV+1     ;SAVE (AC3) + 1
00133'010424          ISZ SWAV+1
00134'021400          LDA 0,0,3        ;GET STAPT ADDRESS
00135'024004$         LDA 1,TRLS       ;GET NUMBER OF TRIALS
00136'044427          STA 1,WORK       ;STORE NUMBER OF TRIALS
00137'107000          ADD 0,1          ;GENERATE FIRST STORE ADDRESS
00140'125400          INC 1,1          ;(DATA STORED IN REVERSE
                                       ;ORDER BY RT PROGRAM)
00141'044030          STA 1,30         ;STORE ADDR. TO AUTO-DEC. LOC
00142'002415          JMP @SWAV+1      ;RETURN

                ;  ROUTINE TO WRITE ON TAPE

00143'054414  TAPE:   STA 3,SWAV+1
00144'004730          JSR LZERO        ;WRITE LEADING ZERO
00145'026030          LDA 1,@30        ;GET NEXT DATUM
00146'006001-         JSR @ATB         ;WRITE ON TAPE
00147'014416          DSZ WORK
00150'000774          JMP TAPE+1
00151'004727          JSR STALL
00152'020423          LDA 0,IRG        ;WRITE IRG
00153'062074          DOB 0,74
00154'004724          JSR STALL
00155'002402          JMP @SWAV+1

      000007  SWAV:   .BLK 7
      000007  WORK:   .BLK 7
00174'000005  FIVE:   5
00175'000004  IRG:    4
00176'000060  C60:    60
00177'000000  SAVE:   0

                ;  G.O. MOELLER BINARY TO ASCII DECIMAL
                ;  TAPE WRITING ROUTINES
                ;  BASED UPON BNDEC IN "INTRODUCTION
                ;  TO PROGRAMMING THE NOVA COMPUTER"
                ;  COPYRIGHT 1972, DATA GENERAL CORPORATION
                ;  REPRODUCED BY PERMISSION
00200'063574  WD:     SKPBZ 74
00201'000777          JMP .-1
00202'061174          DOAS 0,74
00203'001400          JMP 0,3
00204'054773  TBNDC:  STA 3,SAVE
00205'034422          LDA 3,INST
00206'054401          STA 3,.+1
00207'000000  LOOP:   0
00210'020766          LDA 0,C60
00211'146443          SUBO 2,1,SNC
00212'101401          INC 0,0,SKP
00213'147001          ADD 2,1,SKP
00214'000775          JMP .-3
00215'004763          JSR WD
00216'010771          ISZ LOOP
00217'151203          MOVR 2,2,SNC
00220'000767          JMP LOOP
00221'002756          JMP @SAVE

      000012          .RDX 10
```

```
00222'023420  TENS:   10000
00223'001750          1000
00224'000144          100
00225'000012          10
00226'000001          1

      000010          .RDX 8
00227'030413  INST:   LDA 2,.+TENS-LOOP

                      .END
```

```
                        .TITL EOF
                        .ENT AEOF

                ;       SUBROUTINE TO WRITE EOF MARKS ON
                ;       CALMA TAPES, WITH PROPER TIMING
                ;       CALL IS VIA     JSR @AEOF
                ;                       NUMBER OF EOF MARKS
                ;                       RETURN
                ;
                ;       G.M.OLSON
                ;       9 NOVEMBER 1972 (A)
      102113            .DALC   SGE=ADCL# 0,0,SNC

                        .ZREL
00000-000000' AEOF:     EOF
00001-000037' ASR:      ISR

                        .NREL

00000'054450  EOF:      STA 3,SAVE          ;SAVE (AC3) + 1
00001'010447            ISZ SAVE
00002'025400            LDA 1,0,3           ;STORE NO. OF FILE
00003'044446            STA 1,SAVE+1        ;MARKS
00004'020001-           LDA 0,ASR           ;STORE ADDRESS OF
00005'040001            STA 0,1             ;INT. ROUTINE
00006'020437            LDA 0,ZERO          ;ZERO TIME
00007'040440            STA 0,COUNT         ;COUNT
00010'020434            LDA 0,CLMSK         ;SET MASK
00011'062177            DOBS 0,CPU
00012'020431            LDA 0,CLKF0         ;SET CLOCK
00013'061114            DOAS 0,RTC          ;TICKING
00014'024443            LDA 1,INT1
00015'004414            JSR CHK
00016'020430  WRT:      LDA 0,FMARK         ;WRITE EOF
00017'062074            DOB 0,74
00020'020425            LDA 0,ZERO          ;ZERO TIME
00021'040426            STA 0,COUNT         ;COUNT
00022'024436            LDA 1,INT2          ;SET SECOND
00023'060114            NIOS RTC            ;INTERVAL
00024'060177            INTEN
00025'004404            JSR CHK
00026'014423            DSZ SAVE+1
00027'000767            JMP WRT
00030'002420            JMP @SAVE
00031'020416  CHK:      LDA 0,COUNT
00032'106113            SGE 0,1
00033'000776            JMP .-2
00034'060277            INTDS
00035'060214            NIOC RTC
00036'001400            JMP 0,3
00037'010410  ISR:      ISZ COUNT
00040'060114            NIOS RTC
00041'060177            INTEN
00042'002000            JMP @0
00043'000001  CLKF0:    1
00044'177773  CLMSK:    177773
00045'000000  ZERO:     0
00046'000010  FMARK:    10
```

```
00047'000000  COUNT:   0
      000007  SAVE:    .BLK 7
      000012           .RDX 10
00057'000062  INT1:    50
00060'000113  INT2:    75
                       .END
```

```
                ;SUBROUTINE TO TYPE OUT THE DATA
                ;       FOR EACH SUBJECT

                        .TITL   DATYP
                        .ENT ADAT,ITYP,BTXT
                        .EXTD ABNDC,APUTC,ADCBN,AGETC,AOUTP
                        .EXTD APE,TRLS,ATYPE,ISTIM,IFORE
                        .EXTD ATIME,ACODE


                                ;ENTRY IS VIA JSR@ ADAT


                        ;27 DEC 1972  --  KEVIN LAXAR
                        ;MODIFIED BY G.M.O. -- 19 MARCH 1973(A)


                        .ZREL
00000-000064' BTXT:     TXT30
00001-000106'           TXT31
00002-000137'           SPACE
00003-000135'           LINE
00004-000005' ADAT:     GODAT
00005-000000  ITYP:     0
                        .NREL
00000'000000  ICT:      0
00001'000000  DCT:      0
00002'000000  ZERO:     0
00003'000000  EVAS:     0
00004'000001  ONE:      1

00005'054776  GODAT:   STA     3,EVAS
00006'024005-           LDA     1,ITYP          ;QUERY RE DATA TYPE OUT.
00007'020775            LDA     0,ONE   ;CHECK FOR "NO"
00010'106415            SUB#    0,1,SNR
00011'002772            JMP     @EVAS   ;IF NO, PROCEED
00012'020001-           LDA     0,BTXT+1        ;IF YES,TYPE HEADING
00013'006010$           JSR     @ATYPE
00014'020007$           LDA     0,TRLS
00015'040764            STA     0,DCT   ;STORE # TRIALS IN DCT
00016'024764            LDA     1,ZERO
00017'044761            STA     1,ICT   ;INITIALIZE CTR.
00020'010760  POOL:     ISZ     ICT
00021'024757            LDA     1,ICT
00022'006001$           JSR@    ABNDC   ;PRINTS TRIAL NUMBER.
00023'020002-           LDA     0,BTXT+2
00024'006010$           JSR@    ATYPE   ;SPACES FOR NEXT CHAR.
00025'034754            LDA     3,DCT
00026'030011$           LDA     2,ISTIM ;(ISTIM) INTO AC2
00027'173000            ADD     3,2     ;AC2=ISTIM + TRIALS COUNT
00030'025000            LDA     1,0,2   ;PUTS (ISTIM + TRIALS) INTO AC0.
00031'006001$           JSR@    ABNDC   ;TYPES THE STIMULUS CODE.
00032'020002-           LDA     0,BTXT+2
00033'006010$           JSR@    ATYPE           ;SPACES
00034'034745            LDA     3,DCT
00035'030012$           LDA     2,IFORE
00036'173000            ADD     3,2
00037'025000            LDA     1,0,2   ;PUTS (IFORE + TRIALS) INTO AC1.
00040'006001$           JSR@    ABNDC   ;TYPES FOREPERIOD.
```

```
00041'020002-          LDA     0,BTXT+2
00042'006010$          JSR@    ATYPE           ;SPACES.
00043'034736           LDA     3,DCT
00044'030013$          LDA     2,ATIME
00045'173000           ADD     3,2
00046'025000           LDA     1,0,2
00047'006001$          JSR@    ABNDC
00050'020002-          LDA     0,BTXT+2
00051'006010$          JSR@    ATYPE
00052'034727           LDA     3,DCT
00053'030014$          LDA     2,ACODE
00054'173000           ADD     3,2
00055'025000           LDA     1,0,2
00056'006001$          JSR@    ABNDC
00057'020003-          LDA     0,BTXT+3
00060'006010$          JSR@    ATYPE   ;CR AND LF.
00061'014720           DSZ     DCT     ;DECR CTR
00062'000736           JMP     POOL    ;IF CTR NOT 0, RETURN & DO NEXT
                                       ;TRIAL.
00063'002720           JMP     @EVAS   ;IF CTR=0, RETURN TO MAIN PROG.


00064'005015  TXT30:   .TXT    *<15><12>
00065'052012  <12>T
00066'050131  YP
00067'020105  E
00070'052517  OU
00071'020124  T
00072'040504  DA
00073'040524  TA
00074'020077  ?
00075'030450  (1
00076'047051  )N
00077'020117  O
00100'051117  OR
00101'024040   (
00102'024462  2)
00103'042531  YE
00104'020123  S
00105'000040   *
00106'005015  TXT31:   .TXT    *<15><12>
00107'052012  <12>T
00110'044522  RI
00111'046101  AL
00112'020040
00113'052123  ST
00114'046511  IM
00115'046125  UL
00116'051525  US
00117'020040
00120'043040   F
00121'050040   P
00122'020040
00123'020040
00124'051040   R
00125'052040   T
00126'020040
00127'020040
00130'041440   C
00131'042117  OD
```

```
00132'006505   E<15>
00133'005012   <12><12>
00134'000000   *
00135'005015   LINE:    .TXT     *<15><12>
00136'000000   *
00137'020040   SPACE:   .TXT     *
00140'000040    *
                        .END
```

```
                ; RANDOM NUMBER GENERATOR (RELOCATABLE SUBROUTINE)
                ; GENERATES A (PSEUDO) RANDOM SEQUENCE OF INTEGERS
                ; IN THE RANGE  0<= N <= 2**16-1

                ; INPUT:        ADDRESS OF OLD VALUE POINTED TO BY WORD
                ;               AFTER JSR

                ; OUTPUT:       16-BIT NEW RANDOM NUMBER IN AC0
                ;               AND IN STORAGE REPLACING OLD VALUE

                ; CALLING SEQUENCE:
                ;       JSR     @ARAND
                ;       ADDRESS OF OLD VALUE
                ;       RETURN

                ; METHOD:       GENERATES A LINEAR CONGRUENTIAL
                ;               SEQUENCE OF THE FORM:
                ;                       X(N+1) = (X(N)*A+C)MOD 2**16

                ; CAUTION:      IF A K-BIT RANDOM NUMBER (AS OPPOSED
                ;               TO A 16- BIT NUMBER) IS NEEDED,
                ;               USE THE MOST SIGNIFIGANT
                ;               K-BITS (THE LEAST SIGNIFIGANT K-BITS
                ;               ARE NOT AS RANDOM).
                ;               FOR EXAMPLE, TO OBTAIN RANDOM N MOD 2,
                ;               USE THE SIGN BIT OF THE RESULT

                ; UNCHANGED:    AC1, AC2
                ; DESTROYED:    AC0, AC3, CARRY
                ;
                ;  ROUTINE ADAPTED FROM NOVA MATH
                ;  SUBROUTINE LIBRARY
                ;  COPYRIGHT 1969, DATA GENERAL CORPORATION
                ;  REPRODUCED BY PERMISSION
                ;
                ;       ADAPTED BY G.M. OLSON
                ;       22 AUGUST 1972 (A)
                        .TITL RANDI
                        .ENT ARAND

                        .NREL
00000'054432    .RAND:  STA 3,.UD03     ; SAVE RETURN
00001'010431            ISZ .UD03       ; BUMP PAST ADDRESS CONSTANT
00002'044426            STA 1,.UD01     ; *SAVE AC1
00003'050426            STA 2,.UD02     ; *SAVE AC2
00004'031400            LDA 2,0,3       ; GET ADDRESS OF OLD VALUE
00005'021000            LDA 0,0,2       ; OLD VALUE TO AC0
00006'004407            JSR .UD50       ; N*A
00007'034425            LDA 3,.UD20     ; GET INCREMENT, C
00010'163000            ADD 3,0         ; (N*A+C) MOD 2**16
00011'041000            STA 0,0,2       ; STORE IT
00012'024416            LDA 1,.UD01     ; *RESTORE AC1
00013'030416            LDA 2,.UD02     ; *RESTORE AC2
00014'002416            JMP @.UD03      ; RETURN



                ; COMPUTE N*(2**11+2**2+1)
```

```
00015'024420  .UD50:  LDA 1,.UD21      ; GET COUNT, X
00016'044415          STA 1,.UD10      ; FOR ITERATION
00017'105120          MOVZL 0,1        ; N*2**(X+1)
00020'125120          MOVZL 1,1
00021'014412          DSZ .UD10
00022'000776          JMP .-2
00023'107000          ADD 0,1
00024'125120          MOVZL 1,1
00025'125120          MOVZL 1,1        ; 2**2*(N*2**(X+1)+N)
00026'123000          ADD 1,0
00027'001400          JMP 0,3          ; N+N*2**2+N*2**(X+3)



00030'000000  .UD01:  0                ; *SAVE AC1
00031'000000  .UD02:  0                ; *SAVE AC2
00032'000000  .UD03:  0                ; SAVE RETURN

00033'000000  .UD10:  0                ; ITERATION COUNT

00034'033031  .UD20:  33031            ; INCREMENT
00035'000010  .UD21:  10               ; ITERATION COUNT, X
                      .ZREL
00000-000000' APAND:  .RAND
                      .END
```

```
                        .TITL PERMUTE
                        .ENT APRMT,OLD
                        .EXTD APAND

                ;       RELOCATABLE SUBROUTINE TO RANDOMLY
                ;PERMUTE THE CONTENTS OF N ADJACENT
                ;MEMORY LOCATIONS.  REQUIRES RELOCATABLE
                ;RANDOM NUMBER GENERATOR ADDRESSED BY
                ;@APAND.
                ;
                ;       CALL TO PERMUTE IS:
                ;               JSR @APRMT
                ;               ADDRESS OF ARRAY
                ;               SIZE OF ARRAY
                ;               RETURN
                ;SEED FOR RANDOM NUMBER GENERATOR IS
                ;PASSED VIA LOCATION "OLD" ON ZERO PAGE.
                ;
                ;               G.M. OLSON
                ;               22 AUGUST 1972 (A)

                        .ZREL
00000-000000'   APRMT:  REP
00001-000000    OLD:    0

                        .NREL
00000'054463    REP:    STA 3,RMSAV
00001'010462            ISZ RMSAV       ;INCREMENT RETURN
00002'010461            ISZ RMSAV       ;ADDRESS BY 2
00003'030020            LDA 2,20        ;SAVE (20)
00004'050460            STA 2,RMSAV+1
00005'031401            LDA 2,1,3       ;SIZE OF ARRAY
00006'050447            STA 2,RCTR
00007'014446            DSZ RCTR        ;DECREMENT FOR RANGE TESTS
00010'050446            STA 2,ZCTR
00011'102460            SUBC 0,0
00012'040445            STA 0,BITC      ;ZERO BIT COUNTER
00013'151123            MOVZL 2,2,SNC   ;CHECK NEXT BIT
00014'000402            JMP .+2         ;IF = 0
00015'000403            JMP .+3         ;IF = 1
00016'010441            ISZ BITC        ;INCREMENT BIT COUNT
00017'000774            JMP .-4         ;ITERATE
00020'031400            LDA 2,0,3       ;ADDRESS OF ARRAY
00021'050020            STA 2,20        ;SAVED IN LOC 20
00022'050437            STA 2,ASAV
00023'014020            DSZ 20          ;BACK UP ONE
00024'020433    AGAIN:  LDA 0,BITC      ;GET BIT COUNT
00025'040435            STA 0,LAX       ;STORE IN LAX
00026'006001$           JSR @APAND      ;GET A RANDOM NUMBER
00027'000001-           OLD
00030'101220            MOVZR 0,0       ;SHIFT RANDOM NUMBER
00031'014431            DSZ LAX         ;DECREMENT BIT COUNT
00032'000776            JMP .-2         ;LOOP
00033'024422            LDA 1,RCTR      ;WHEN DONE SHIFTING,
00034'122033            ADCZ# 1,0,SNC   ;CHECK IF GREATER
00035'000402            JMP .+2         ;THAN SIZE OF ARRAY
00036'000766            JMP AGAIN       ;GET NEW RANDOM NUMBER
00037'026020            LDA 1,@20       ;GET ADDRESS OF NEXT
                                        ;ARRAY ELEMENT
```

```
00040'044420            STA 1,TEMP      ;SET ASIDE
00041'014020            DSZ 20          ;BACK UP ADDRESS COUNT
00042'030417            LDA 2,ASAV
00043'113000            ADD 0,2         ;CREATE ADDRESS FOR
                                        ;SWAP
00044'025000            LDA 1,0,2       ;SWAP OLD (20)
00045'046020            STA 1,@20       ;AND (START + X)
00046'024412            LDA 1,TEMP
00047'045000            STA 1,0,2
00050'014406            DSZ ZCTR        ;DECREMENT RANGE COUNT
00051'000753            JMP AGAIN       ;LOOP
00052'030412            LDA 2,PMSAV+1   ;RESTORE (20)
00053'050020            STA 2,20
00054'002407            JMP @PMSAV

00055'000000  PCTP:     0
00056'000000  ZCTR:     0
00057'000000  BITC:     0
00060'000000  TEMP:     0
00061'000000  ASAV:     0
00062'000000  LAX:      0
      000002  PMSAV:    .BLK 2
                        .END
```

```
                ;INOUT --  SUBROUTINE PACKAGE CONTAINING
                ;       PUTC, GETC, BNOCT, OCTBN, BNDEC, AND
                ;       DECBN IN RELOCATABLE FORM,
                ;       WITH ENTRY POINTS APUTC, AGETC, ABNOC,
                ;       AOCBN, ABNDC, AND ADCBN.  FOLLOWING
                ;       ASSUMPTIONS ARE MADE ON ENTRY:
                ;               PUTC:  CHARACTER TO TTO
                ;                      IN AC0
                ;               GETC:  CHARACTER FROM TTI
                ;                      IN AC0
                ;               BNOCT: BINARY NUMBER INPUT
                ;                      TO BNOCT IS IN AC1
                ;               OCTBN: BINARY NUMBER OUTPUT
                ;                      FROM OCTBN WILL BE
                ;                      IN AC1
                ;               BNDEC: BINARY NUMBER INPUT
                ;                      TO BNDEC IS IN AC1
                ;               DECBN: BINARY NUMBER OUTPUT
                ;                      FROM DECBN WILL BE
                ;                      IN AC1
                ;       ALL SUBROUTINES REQUIRE AC0, AC1, AND AC3.
                ;       IN ADDITION, BNOCT AND BNDEC ALSO
                ;       REQUIRE AC2.
                ;       SPECIAL NOTES:  IF GETC IS TO BE
                ;       ENTERED BECAUSE OF A TTI
                ;       INTERRUPT, THE ENTRY POINT MUST BE
                ;       IGETI, AND IT WILL BE ASSUMED
                ;       THAT NIOS TTI OR THE EQUIVALENT
                ;       WILL BE PART OF THE INTERRUPT SERVICE
                ;       ROUTINE.
                ;       *******ALL THESE ROUTINES EXCEPT DECBN
                ;       ARE COPIES OR ADAPTATIONS OF THOSE
                ;       DESCRIBED IN THE DATA GENERAL MANUAL,
                ;       "INTRODUCTION TO PROGRAMMING THE NOVA
                ;       COMPUTERS."  PROGRAM LISTINGS AND
                ;       COMMENTS ARE IN APPENDIX A OF THAT
                ;       MANUAL.  DECBN IS COPIED FROM THE
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                ;       DESCRIBED IN THE APPROPRIATE
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                ;       THE SPECIAL FEATURES OF DECBN
                ;       ARE PRESERVED IN THIS VERSION.
                ;       CONSULT THE MATH LIBRARY DOCUMENTS
                ;       FOR DETAILS.


                ;       G.M. OLSON
                ;       14 DECEMBER 1972 (A)


                        .TITL INOUT
                        .ENT APUTC,AGETC,ABNOC,AOCBN
                        .ENT ABNDC,ADCBN,IGETI,IDBIN
                        .NREL

00000'054416  BNOCT:  STA     3,SAVE
00001'152620          SUBZR   2,2
00002'020413  LOOP:   LDA     0,C60
```

```
00003'146443            SUBO    2,1,SNC
00004'101401            INC     0,0,SKP
00005'147001            ADD     2,1,SKP
00006'000775            JMP     .-3
00007'004437            JSR     PUTC
00010'151220            MOVZR   2,2
00011'151220            MOVZR   2,2
00012'151224            MOVZR   2,2,SZR
00013'000767            JMP     LOOP
00014'002402            JMP     @SAVE

00015'000060  C60:      60
      000007  SAVE:     .BLK 7

00025'054517  GETI:     STA     3,SGET
00026'000403            JMP     .+3
00027'054515  GETC:     STA     3,SGET
00030'060110            NIOS    TTI
00031'063610            SKPDN   TTI
00032'000777            JMP     .-1
00033'060610            DIAC    0,TTI
00034'034513            LDA     3,MSK
00035'163400            AND     3,0
00036'004410            JSR     PUTC
00037'034507            LDA     3,CR
00040'116404            SUB     0,3,SZR
00041'002503            JMP     @SGET
00042'020506            LDA     0,LF
00043'004403            JSR     PUTC
00044'020502            LDA     0,CR
00045'002477            JMP     @SGET

00046'063511  PUTC:     SKPBZ   TTO
00047'000777            JMP     .-1
00050'061111            DOAS    0,TTO
00051'101004            MOV     0,0,SZR
00052'001400            JMP     0,3
00053'054472            STA     3,SPUT
00054'020472            LDA     0,CR
00055'004771            JSR     PUTC
00056'020472            LDA     0,LF
00057'004767            JSR     PUTC
00060'102400            SUB     0,0
00061'002464            JMP     @SPUT

00062'054734  BNDEC:    STA     3,SAVE
00063'034460            LDA     3,ZERO
00064'054454            STA     3,SUPP
00065'034454            LDA     3,FIVE
00066'054451            STA     3,LAST
00067'034446            LDA     3,INST
00070'054401            STA     3,.+1
00071'000000  KOOP:     0
00072'020723            LDA     0,C60
00073'146443            SUBO    2,1,SNC
00074'101401            INC     0,0,SKP
00075'147001            ADD     2,1,SKP
00076'000775            JMP     .-3
00077'050720            STA     2,SAVE+1
00100'014437            DSZ     LAST
```

```
00101'000402            JMP     .+2
00102'000420            JMP     SOAR
00103'034435            LDA     3,SUPP
00104'030437            LDA     2,ZERO
00105'156414            SUB#    2,3,SZR
00106'000414            JMP     SOAR
00107'030433            LDA     2,ONE
00110'034705            LDA     3,C60
00111'116414            SUB#    0,3,SZR
00112'000407            JMP     SOAR-1
00113'040705            STA     0,SAVE+2
00114'020422            LDA     0,BLANK
00115'004731            JSR     PUTC
00116'020702            LDA     0,SAVE+2
00117'030700            LDA     2,SAVE+1
00120'000404            JMP     SOAR+2
00121'050417            STA     2,SUPP
00122'004724  SOAR:     JSR     PUTC
00123'030674            LDA     2,SAVE+1
00124'010745            ISZ     KOOP
00125'151203            MOVR    2,2,SNC
00126'000743            JMP     KOOP
00127'002667            JMP     @SAVE
      000012            .RDX    10
00130'023420  TENS:     10000
00131'001750            1000
00132'000144            100
00133'000012            10
00134'000001            1
      000010            .RDX    8
00135'030437  INST:     LDA     2,.+TENS-KOOP

00136'000040  BLANK:    40
00137'000000  LAST:     0
00140'000000  SUPP:     0
00141'000005  FIVE:     5
00142'000001  ONE:      1
00143'000000  ZERO:     0
00144'000000  SGET:     0
00145'000000  SPUT:     0
00146'000015  CR:       15
00147'000177  MSK:      177
00150'000012  LF:       12

00151'054645  OCTBN:    STA     3,SAVE
00152'126400            SUB     1,1
00153'004654  OCT1:     JSR     GETC
00154'034772            LDA     3,CR
00155'116415            SUB#    0,3,SNR
00156'002640            JMP     @SAVE
00157'034406            LDA     3,C7
00160'163400            AND     3,0
00161'127120            ADDZL   1,1
00162'125120            MOVZL   1,1
00163'107000            ADD     0,1
00164'000767            JMP     OCT1
00165'000007  C7:       7
```

```
00166'054455  .DECI:  STA 3,.EC03      ; SAVE RETURN
00167'050453          STA 2,.EC02      ; SAVE AC2
00170'020462          LDA 0,.EC24      ; GET "S"
00171'006002-         JSR @APUTC       ; SEND "S"
00172'102400          SUB 0,0
00173'006002-         JSR @APUTC       ; SEND NULL
00174'000403          JMP .+3
00175'054446  DECEN:  STA 3,.EC03      ; SAVE AC3
00176'050444          STA 2,.EC02      ; SAVE AC2
00177'102400          SUB 0,0
00200'040444          STA 0,.EC10      ; CLEAR SIGN WORD
00201'040444          STA 0,.EC11      ; CLEAR SUM WORD
00202'006003-         JSR @AGETC       ; GET A CHARACTER
00203'024443          LDA 1,.EC20      ; TEST FOR "+"
00204'106405          SUB 0,1,SNR
00205'000405          JMP .EC97        ; YES
00206'024441          LDA 1,.EC21      ; NO, TEST FOR "-"
00207'106404          SUB 0,1,SZR
00210'000403          JMP .EC96        ; NO EXPLICIT SIGN
00211'010433          ISZ .EC10        ; SET FLAG WORD FOR NEGATIVE
                                       ; NUMBER
00212'006003-  .EC97: JSR @AGETC       ; GET ANOTHER CHARACTER
00213'024435  .EC96:  LDA 1,.EC22      ; ASCII "0"
00214'030435          LDA 2,.EC23      ; ASCII "9"
00215'142033          ADCZ# 2,0,SNC    ; SKIP IF > 9
00216'106032          ADCZ# 0,1,SZC    ; SKIP IF >= 0
00217'000406          JMP .EC95        ; NOT A DIGIT, THERFORE A BREAK
                                       ; CHARACTER
00220'122400          SUB 1,0          ; REDUCE DIGIT TO 0-9 BINARY
                                       ; RANGE
00221'024424          LDA 1,.EC11      ; SUM WORD
00222'004412          JSR .EC50        ; MULTIPLY BY 10 AND ADD
00223'044422          STA 1,.EC11      ; SAVE SUM
00224'000766          JMP .EC97        ; GET NEXT CHARACTER



00225'024420  .EC95:  LDA 1,.EC11      ; RESULT TO AC1
00226'125120          MOVZL 1,1
00227'014415          DSZ .EC10        ; TEST SIGN
00230'125221          MOVZR 1,1,SKP    ; POSITIVE
00231'124640          NEGOR 1,1        ; NEGATIVE
00232'030410          LDA 2,.EC02      ; RESTORE AC2
00233'002410          JMP @.EC03


              ; ROUTINE TO MULTIPLY AC1 BY 10 AND ADD AC0


00234'131120  .EC50:  MOVZL 1,2        ; N*2
00235'151120          MOVZL 2,2        ; N*4
00236'147000          ADD 2,1          ; N*5
00237'125120          MOVZL 1,1        ; N*5*2 = N*10
00240'107000          ADD 0,1          ; ADD AC0
00241'001400          JMP 0,3          ; SUCCESS RETURN



00242'000000  .EC02:  0                ; SAVE AC2
00243'000000  .EC03:  0                ; SAVE AC3
```

```
00244'000000  .EC10:  0                ; FLAG WORD FOR SIGN OF RESULT
00245'000000  .EC11:  0                ; RUNNING SUM WORD

00246'000053  .EC20:  "+               ; ASCII "+"
00247'000055  .EC21:  "-               ; ASCII "-"
00250'000060  .EC22:  "0               ; ASCII "0"
00251'000071  .EC23:  "9               ; ASCII "9"
00252'000123  .EC24:  "S               ; ASCII "S" FOR INDICATION
                                       ; ENTRY
                      .ZPEL
00000-000062' ABNDC:  BNDEC
00001-000175' ADCBN:  DECBN
00002-000046' APUTC:  PUTC
00003-000027' AGETC:  GETC
00004-000000' ABNOC:  BNOCT
00005-000151' AOCBN:  OCTBN
00006-000025' IGETI:  GETI
00007-000166' IDBIN:  .DBNI
                      .END
```

```
                        ;BYTE POINTER SUBPT,STEPS THRU MESSAGE
                        ;TYPING UNTIL ENCOUNTERS NULL CHARACTER.
                        ;
                        ;  WRITE TO WRITE+7 TAKEN FROM
                        ;  "HOW TO USE THE NOVA COMPUTERS"
                        ;  COPYRIGHT 1971, DATA GENERAL CORPORATION
                        ;  REPRODUCED BY PERMISSION
                        ;
                        ;CALL AS FOLLOWS: (MESS=MESSAGE ADDRESS)
                        ;       LDA     0,MESS
                        ;       MOVZL   0,0
                        ;       STA     0,.+2
                        ;       JSR     @AOUTP
                        ;       0
                        ;       RETURN HERE
                        ;
                        ;BMAN + PUTC USE ALL AC. SAVE AC1+AC2
                        ;ON ENTRY, RESTORE ON RETURN
                        ;
                        ;       G.O. MOELLER
                        ;       AUGUST 19 1972 (A)

                                .TITL BMAN
                                .ENT AOUTP
                                .EXTD APUTC
                                .NREL
                        ;
00000'054424    OUTP:   STA     3,SVOUT
00001'054424            STA     3,SVOUT+1
00002'050424            STA     2,SVOUT+2
00003'044424            STA     1,SVOUT+3
00004'010420            ISZ     SVOUT
                        ;  STEP THRU MESSAGE
00005'032420    WRITE:  LDA@    2,SVOUT+1       ;CF "HOW TO..", 2-21
00006'012417            ISZ@    SVOUT+1
00007'151220            MOVZR   2,2
00010'021000            LDA     0,0,2
00011'030412            LDA     2,C377
00012'101002            MOV     0,0,SZC
00013'101300            MOVS    0,0
00014'143405            AND     2,0,SNR
00015'000403            JMP     .+3
00016'006001$           JSR@    APUTC
00017'000766            JMP     WRITE
00020'030406            LDA     2,SVOUT+2
00021'024406            LDA     1,SVOUT+3
00022'002402            JMP@    SVOUT
                        ;
00023'000377    C377:   377
      000004    SVOUT:  .BLK 4
                        .ZREL
00000-000000'   AOUTP:  OUTP
                        ;
                        .END
```

```
                ;SUBROUTINE TO CLEAR N LOCATIONS,
                ;ANY AREA BEYOND END OF ZMEM.
                ;ZMEM REQUIRES 30 WORDS.
                ;
                ;CALL WITH JSR@ ACLER.
                ;IF JSR LOCATED AT PC
                ;PC+1 = NO. LOCS TO CLEAR
                ;PC+2 = ADDRESS OF AREA.
                ;
                ;ZMEM USES LOC 20,AC2,AC3
                ;SAVES PREVIOUS (20) + (AC2)
                ;AS ANY JSR, SAVE (AC3) BEFORE
                ;CALL - IF NECESSARY.
                ;
                ;               G.O. MOELLER
                ;               11 AUGUST 1972 (A)
                ;
                        .TITL   NZMEM
                        .ENT    ACLER
                        .NREL
                ;
00000'054425    CLEAR:  STA     3,CTS   ;SET RETURN ADDRESS,
00001'010424            ISZ     CTS     ;SAVE (AC2), (AC3) AND
00002'010423            ISZ     CTS     ;(20).
00003'050423            STA     2,CTS+1
00004'030020            LDA     2,20
00005'050422            STA     2,CTS+2
00006'031400            LDA     2,0,3   ;SET CTR, #LOCS TO ZERO
00007'050414            STA     2,ZCTR
00010'031401            LDA     2,1,3   ;START ADDRESS, AREA TO BE ZEROED
00011'050020            STA     2,20    ;TO LOC 20.
00012'014020            DSZ     20
00013'030411            LDA     2, ZERCL
00014'052020            STA@    2,20
00015'014406            DSZ     ZCTR
00016'000776            JMP     .-2
00017'034410            LDA     3,CTS+2
00020'054020            STA     3,20
00021'030405            LDA     2,CTS+1
00022'002403            JMP@    CTS
00023'000000    ZCTR    :0
00024'000000    ZERCL   :0
      000003    CTS     :.BLK   3
                        .ZREL
00000-000000'   ACLER   :CLEAR
                ;
                        .END
```

```
                ; POUTINE TO PPINT MESSAGES
                ; ON CPT -- STOPS WHEN
                ; ENCOUNTEPS NULL CHAPACTEP
                ;
                ;  DELTA TO DELTA+7 BASED ON EXAMPLE
                ;  IN "HOW TO USE THE NOVA COMPUTEPS"
                ;  COPYPIGHT 1971, DATA GENEPAL COPPOPATION
                ;  PEPPODUCED BY PEPMISSION
                ;
                ;       G.M. OLSON
                ;       2 MAPCH 1973 (A)

                        .TITL CPTXT
                        .ENT SHOW
                        .EXTD CHAP

                        .ZPEL
00000-000000'   SHOW:   GAMMA

                        .NPEL
00000'054426    GAMMA:  STA 3,OUT       ;SAVE (AC3) FOP PETUPN
00001'054426            STA 3,OUT+1     ;SAVE (AC3) FOP CHAP. APPAY
00002'050426            STA 2,OUT+2     ;SAVE (AC2)
00003'044426            STA 1,OUT+3     ;SAVE (AC1)
00004'010422            ISZ OUT         ;BUMP PETUPN
00005'032422    DELTA:  LDA 2,@OUT+1    ;LOAD CHAP. WOPD
00006'012421            ISZ @OUT+1      ;INCPEMENT
00007'151220            MOVZP 2,2       ;POTATE TO PIGHT
00010'021000            LDA 0,0,2       ;LOAD CHAP
00011'030421            LDA 2,C377      ;LOAD MASK
00012'101002            MOV 0,0,SZC     ;CHECK CAPPY
00013'101300            MOVS 0,0        ;SWAP BYTES
00014'143405            AND 2,0,SNP     ;CHECK IF NULL
00015'000405            JMP MU          ;EXIT
00016'040407            STA 0,TEMP
00017'006001$           JSP @CHAP       ;CHAPACTEP TO CPT
00020'000025'           TEMP
00021'000764            JMP DELTA       ;LOOP
00022'030406    MU:     LDA 2,OUT+2     ;PESTOPE (AC2) +
00023'024406            LDA 1,OUT+3     ;       (AC1)
00024'002402            JMP @OUT
00025'000000    TEMP:   0
      000004    OUT:    .BLK 4
00032'000377    C377:   377
                        .END
```

```
                ;SUBROUTINE BOX -- DRAWS RIGHT-LEFT DIAGRAMS
                ;ON CRT (BASED ON OLSON AND LAXAR, JOURNAL
                ;OF EXPERIMENTAL PSYCHOLOGY, 1973)
                ;CALLING SEQUENCE:       JSP @PLBOX
                ;                        STIMULUS CODE
                ;                        RETURN
                ;STIMULUS CODE:  1 = "RIGHT"-RIGHT
                ;                2 = "RIGHT" - LEFT
                ;                3 = "LEFT" - RIGHT
                ;                4 = "LEFT" - LEFT
                ;
                ;                G.M. OLSON
                ;                26 MARCH 1973 (A)


                        .TITL BOX
                        .ENT PLBOX
                        .EXTD SKTCH

                        .ZREL
00000-000026'   PLBOX:  START

                        .NREL
00000'000000    TEMP:   0
00001'000000    MODE:   0
00002'000000    ZERO:   0
00003'000001    ONE:    1
00004'000005    FIVE:   5
00005'000006    SIX:    6
00006'000000    COUNT:  0
00007'000000    TEMPX:  0
00010'000000    TEMPY:  0
00011'000000    TEMPT:  0
00012'000000    MODOC:  0
00013'000137'   RXLOC:  XR
00014'000145'   RYLOC:  YR
00015'000153'   RTLOC:  TOTR
00016'000161'   LXLOC:  XL
00017'000166'   LYLOC:  YL
00020'000173'   LTLOC:  TOTL
00021'000202'   LDIAX:  XLD
00022'000200'   RDIAX:  XRD
00023'000201'   DIAY:   YD
00024'000203'   DIAT:   TOTD
00025'000000    OBAN:   0

00026'054764    START:  STA 3,MODOC     ;SAVE (AC3)+1 FOR
00027'010763            ISZ MODOC       ;RETURN
00030'025400            LDA 1,0,3       ;LOAD CODE NO.
00031'020752            LDA 0,ONE       ;SUBTRACT 1 FROM CODE
00032'106400            SUB 0,1
00033'125220            MOVZR 1,1       ;SAVE CODE BIT FOR
00034'152460            SUBC 2,2        ;DIAMOND
00035'151100            MOVL 2,2        ;
00036'050767            STA 2,OBAN
00037'125222            MOVZR 1,1,SZC   ;CHECK IF WORD IS:
00040'000413            JMP LEFT        ;"LEFT"
00041'030752            LDA 2,RXLOC     ;"RIGHT" -- LOAD PARAMETERS
00042'050745            STA 2,TEMPX
00043'030751            LDA 2,RYLOC
```

```
00044'050744            STA 2,TEMPY
00045'030750            LDA 2,RTLOC
00046'050743            STA 2,TEMPT
00047'030736            LDA 2,SIX
00050'050736            STA 2,COUNT
00051'004427            JSR DRAW        ;DRAW "RIGHT"
00052'000412            JMP YUROK       ;GO TO DRAW DIAMOND
00053'030743  LEFT:     LDA 2,LXLOC     ;LOAD "LEFT" PARAMETERS
00054'050733            STA 2,TEMPX
00055'030742            LDA 2,LYLOC
00056'050732            STA 2,TEMPY
00057'030741            LDA 2,LTLOC
00060'050731            STA 2,TEMPT
00061'030723            LDA 2,FIVE
00062'050724            STA 2,COUNT
00063'004415            JSR DRAW        ;DRAW "LEFT"
00064'030735  YUROK:    LDA 2,LDIAX     ;DRAW APPROPRIATE
00065'014740            DSZ OBAN        ;DIAMOND
00066'030734            LDA 2,RDIAX
00067'050720            STA 2,TEMPX
00070'030733            LDA 2,DIAY
00071'050717            STA 2,TEMPY
00072'030732            LDA 2,DIAT
00073'050716            STA 2,TEMPT
00074'030707            LDA 2,ONE
00075'050711            STA 2,COUNT
00076'004402            JSR DRAW
00077'002713            JMP @MODOC      ;EXIT FROM SUBROUTINE
00100'054436  DRAW:     STA 3,TEJON     ;DRAW ON CRT
00101'020701            LDA 0,ZERO      ;SET FOR DARK VECTOR
00102'040677            STA 0,MODE
00103'030704            LDA 2,TEMPX     ;SET X
00104'021000            LDA 0,0,2
00105'040414            STA 0,XVAR
00106'030702            LDA 2,TEMPY     ;SET Y
00107'021000            LDA 0,0,2
00110'040412            STA 0,YVAR
00111'030700            LDA 2,TEMPT     ;SET COUNT OF X,Y PAIRS
00112'021000            LDA 0,0,2
00113'040665            STA 0,TEMP
00114'000403            JMP .+3
00115'020666  PLOT:     LDA 0,ONE       ;SET FOR BRIGHT VECTOR
00116'040663            STA 0,MODE
00117'006001$           JSR @SKTCH      ;JUMP TO ALS
00120'000001'           MODE
00121'000000  XVAR:     0
00122'000000  YVAR:     0
00123'010776            ISZ XVAR        ;INCREMENT POINTERS
00124'010776            ISZ YVAR
00125'014653            DSZ TEMP        ;CHECK IF FINISHED
                                        ;WITH BRIGHT VECTOR
00126'000767            JMP PLOT        ;CONTINUE WITH BRIGHT VECTOR
00127'014657            DSZ COUNT       ;CHECK IF DRAWING DONE
00130'000402            JMP .+2
00131'002405            JMP @TEJON      ;EXIT
00132'010655            ISZ TEMPX       ;SET FOR NEXT DARK
00133'010655            ISZ TEMPY       ;VECTOR
00134'010655            ISZ TEMPT
00135'000744            JMP DRAW+1
00136'000000  TEJON:    0
```

```
00137'000204' XR:       BX
00140'000216'           RX
00141'000240'           IX
00142'000254'           GX
00143'000300'           HX
00144'000314'           TPX
00145'000211' YR:       BY
00146'000227'           RY
00147'000246'           ITY
00150'000266'           GY
00151'000306'           HY
00152'000246'           ITY
00153'000005  TOTR:     5
00154'000011            11
00155'000006            6
00156'000012            12
00157'000006            6
00160'000004            4
00161'000204' XL:       BX
00162'000324'           LX
00163'000332'           EX
00164'000350'           FX
00165'000320'           TLX
00166'000211' YL:       BY
00167'000327'           LY
00170'000341'           EFY
00171'000341'           EFY
00172'000246'           ITY
00173'000005  TOTL:     5
00174'000003            3
00175'000007            7
00176'000006            6
00177'000004            4
00200'000356' XRD:      DRX
00201'000370' YD:       DY
00202'000363' XLD:      DLX
00203'000005  TOTD:     5

      000012            .RDX 10
00204'000620  BX:       400
00205'001274            700
00206'001274            700
00207'000620            400
00210'000620            400
00211'001130  BY:       600
00212'001130            600
00213'000454            300
00214'000454            300
00215'001130            600
00216'000654  RX:       428
00217'000654            428
00220'000714            460
00221'000724            468
00222'000724            468
00223'000714            460
00224'000654            428
00225'000710            456
00226'000724            468
00227'000644  RY:       420
00230'000740            480
```

```
00231'000740            480
00232'000730            472
00233'000704            452
00234'000674            444
00235'000674            444
00236'000674            444
00237'000644            420
00240'000750  IX:       488
00241'000760            496
00242'000754            492
00243'000754            492
00244'000750            488
00245'000760            496
00246'000740  ITY:      480
00247'000740            480
00250'000740            480
00251'000644            420
00252'000644            420
00253'000644            420
00254'001034  GX:       540
00255'001054            556
00256'001054            556
00257'001044            548
00260'001014            524
00261'001004            516
00262'001004            516
00263'001014            524
00264'001044            548
00265'001054            556
00266'000674  GY:       444
00267'000674            444
00270'000654            428
00271'000644            420
00272'000644            420
00273'000654            428
00274'000730            472
00275'000740            480
00276'000740            480
00277'000730            472
00300'001140  HX:       608
00301'001140            608
00302'001140            608
00303'001074            572
00304'001074            572
00305'001074            572
00306'000644  HY:       420
00307'000740            480
00310'000702            450
00311'000702            450
00312'000644            420
00313'000740            480
00314'001160  TRX:      624
00315'001240            672
00316'001210            648
00317'001210            648
00320'001150  TLX:      616
00321'001230            664
00322'001200            640
00323'001200            640
00324'000670  LX:       440
```

```
00325'000670                    440
00326'000740                    480
00327'000740  LY:               480
00330'000644                    420
00331'000644                    420
00332'001034  EX:               540
00333'000764                    500
00334'000764                    500
00335'001010                    520
00336'000764                    500
00337'000764                    500
00340'001034                    540
00341'000740  EFY:              480
00342'000740                    480
00343'000702                    450
00344'000702                    450
00345'000702                    450
00346'000644                    420
00347'000644                    420
00350'001130  FX:               600
00351'001060                    560
00352'001060                    560
00353'001104                    580
00354'001060                    560
00355'001060                    560
00356'001510  DRX:              840
00357'001440                    800
00360'001370                    760
00361'001440                    800
00362'001510                    840
00363'000404  DLX:              260
00364'000454                    300
00365'000524                    340
00366'000454                    300
00367'000404                    260
00370'000702  DY:               450
00371'000752                    490
00372'000702                    450
00373'000632                    410
00374'000702                    450

                                .END
```

```
                        ;                SUBROUTINE SALS
                        ;   ABBREVIATED VERSION OF TEKTRONIX PLOT-10
                        ;        FOR NOVA MINICOMPUTERS
                        ;   "*" = NAVSUBMEDRSCHLAB MODIFICATION
                        ;
                        ;        G.M.OLSON
                        ;        6 APRIL 1973 (A)
                        ;

                                 .TITL   SALS     ;*
                                 .ENT CHAR,SKTCH  ;*
              000050             CRI=50           ;*
              000051             CRO=51           ;*

                                 .ZREL            ;*
00000-000000' CHAR:    CHOUT     ;*
00001-000010' SKTCH:   TPLOT     ;*

                                 .NREL
                        ;
                        ;        RELEASE 2  72-MAY-11
                        ;        COPYRIGHTED BY TEKTRONIX, INC.  1972
                        ;        REPRODUCED BY PERMISSION
                        ;
                        ;
                        ;
                        ;        CHOUT
                        ;        THIS ROUTINE IS CALLED TO OUTPUT
                        ;        AN ASCII CHARACTER TO THE 4010
                        ;        GRAPHIC COMPUTER TERMINAL
                        ;
                        ;        TO CALL:
                        ;*       JSR      @CHAR
                        ;        ADDRESS OF WORD WITH CHARACTER
                        ;        RETURN HERE
                        ;
00000'040407   CHOUT:   STA      0,CCAC0 ;SAVE AC0
00001'063551            SKPBZ    CRO      ;SKIP IF NOT BUSY
00002'000777            JMP      .-1
00003'023400            LDA      0,@0,3  ;GET CHARACTER
00004'061151            DOAS     0,CRO    ;SHIP CHARACTER
00005'020402            LDA      0,CCAC0 ;RESTORE AC0
00006'001401            JMP      1,3
                        ;
00007'000000   CCAC0:   0                ;TEMP FOR AC0
                        ;
                        ;
                        ;        TPLOT
                        ;          THIS ROUTINE IS CALLED TO PLOT
                        ;        IN LINEAR INTERPOLATE (VECTOR),
                        ;        POINT PLOT MODE
                        ;        DEPENDING ON THE VALUE OF THE MODE
                        ;        PARAMETER
                        ;
                        ;        IF MODE
                        ;        = 0      INITIALZE AND DARK VECTOR TO X,Y
                        ;        > 0      BRIGHT VECTOR TO X,Y
                        ;        < 0      POINT PLOT TO X,Y
```

```
                        ;
                        ;
                        ;       TO CALL:
                        ;*      JSR     @SKTCH
                        ;       ADDRESS OF MODE PARAMETER
                        ;       ADDRESS OF X
                        ;       ADDRESS OF Y
                        ;       RETURN HERE
                        ;
00010'040516  TPLOT:    STA     0,TPTAC0;SAVE AC0
00011'023401            LDA     0,@1,3  ;GET X
00012'040516            STA     0,TPTX
00013'023402            LDA     0,@2,3  ;GET Y
00014'040515            STA     0,TPTY
00015'023400            LDA     0,@0,3  ;GET MODE
00016'040514            STA     0,TPMOD
00017'054510            STA     3,TPTADD;SAVE CALL ADDRESS
00020'101015            MOV#    0,0,SNR ;SKP IF NE0 0
00021'000405            JMP     TPTDV   ;= 0  INITIALIZE AND DARK VECTOR
00022'101113            MOVL#   0,0,SNC ;SKIP IF < 0
00023'000405            JMP     TPTNRM  ;NORMAL BRIGHT VECTOR
00024'006000-           JSR     @CHAR   ;*SET TO ALPHA
00025'000120'           US
00026'006000-  TPTDV:   JSR     @CHAR   ;*DARK VECTOR
00027'000117'           GS
                        ;
00030'020501  TPTNRM:   LDA     0,TPTY  ;GET Y
00031'101112            MOVL#   0,0,SZC ;SKP IF +
00032'102400            SUB     0,0     ;MAKE 0
00033'034471            LDA     3,D780  ;UPPER Y BOUND
00034'162513            SUBL#   3,0,SNC ;SKP IF ON SCREEN
00035'161000            MOV     3,0     ;SET TO EDGE
00036'040473            STA     0,TPTY  ;SAVE GOOD Y
00037'103120            ADDZL   0,0     ;*USE UPPER 5 BITS
00040'101120            MOVZL   0,0
00041'101300            MOVS    0,0     ;AND SWAP HALVES
00042'034457            LDA     3,B040  ;HI Y TAG
00043'163000            ADD     3,0     ;PUT IN CHAR
00044'040467            STA     0,TPTTMP;USE A TEMP
00045'006000-           JSP     @CHAR   ;*SHIP HI Y 5
00046'000133'           TPTTMP
00047'020462            LDA     0,TPTY  ;GET Y
00050'034450            LDA     3,B037  ;MASK
00051'163400            AND     3,0     ;LEAVE LOW Y 5
00052'034451            LDA     3,B140  ;LOW Y TAG
00053'163000            ADD     3,0     ;SET IN CHAR
00054'040457            STA     0,TPTTMP
00055'006000-           JSP     @CHAR   ;*SHIP LOW Y
00056'000133'           TPTTMP
                        ;
00057'020451            LDA     0,TPTX  ;GET X VALUE
00060'101112            MOVL#   0,0,SZC ;*
00061'102400            SUB     0,0     ;*
00062'034443            LDA     3,D1023 ;*
00063'162513            SUBL#   3,0,SNC ;*
00064'161000            MOV     3,0     ;*
00065'040443            STA     0,TPTX  ;*
00066'103120            ADDZL   0,0     ;*AND SO ON
00067'101120            MOVZL   0,0
00070'101300            MOVS    0,0     ;HI X 5
```

```
00071'034430            LDA     3,B040  ;HI X TAG
00072'163000            ADD     3,0     ;ADD IN TAG
00073'040440            STA     0,TPTTMP
00074'006000-           JSR     @CHAR   ;*SHIP HI X 5
00075'000133'           TPTTMP
00076'020432            LDA     0,TPTX  ;GET X
00077'034421            LDA     3,B037  ;GOODIE MASK
00100'163400            AND     3,0     ;LEAVE LOW X 5
00101'034421            LDA     3,B100  ;LOW X TAG
00102'163000            ADD     3,0     ;PUT IN TAG
00103'040430            STA     0,TPTTMP
00104'006000-           JSR     @CHAR   ;*
00105'000133'           TPTTMP
00106'020424            LDA     0,TPMOD
00107'101113            MOVL#   0,0,SNC
00110'000404            JMP     TPTEXT
00111'102400            SUB     0,0
00112'040420            STA     0,TPMOD
00113'000715            JMP     TPTNPM
00114'020412  TPTEXT:   LDA     0,TPTAC0;RESTORE AC0
00115'034412            LDA     3,TPTADD;CALL ADDRESS
00116'001403            JMP     3,3     ;EXIT
                ;
                ;
                ;
                ;       CONSTANTS AND VARIABLES
                ;
00117'000035  GS:       035
00120'000037  US:       037
                ;
      000120' B037=US
00121'000040  B040:     040
00122'000100  B100:     100
00123'000140  B140:     140
                ;
00124'001414  D780:     1414    ;MAX VISIBLE Y
00125'001777  D1023:    1777    ;MAX VISIBLE X
                ;
00126'000000  TPTAC0:   0
00127'000000  TPTADD:   0
00130'000000  TPTX:     0
00131'000000  TPTY:     0
00132'000000  TPMOD:    0
00133'000000  TPTTMP:   0
                        .END
```

```
                ;  SUBROUTINE PTANL -- DOES SIMPLE ANALYSIS
                ;OF PT DATA:
                ;       STANDARD ANALYSIS INCLUDES--
                ;        1. OVERALL RESULTS
                ;        2. ANALYSIS BY STIMULI (IF MORE THAN ONE)
                ;        3. ANALYSIS BY FOREPERIODS (IF MORE THAN ONE)
                ;        4. ANALYSIS BY STIMULI X FOREPERIODS (IF BOTH
                ;             MORE THAN ONE)
                ;        ALL OF THESE ARE DONE FOR
                ;             A. ALL DATA
                ;             B. CORRECTS ALONE  )ONLY IF ERRORS
                ;             C. ERRORS ALONE    )ARE POSSIBLE

                ;        OPTIONAL ANALYSIS --
                ;             ALL OF THE ABOVE DONE BY BLOCKS,
                ;             WHERE BLOCK SIZE IS ENTERED AT
                ;             TIME OF ANALYSIS
                ;             ***NOTE: IT IS UP TO THE USER
                ;               TO CREATE MEANINGFUL BLOCK SIZES
                ;
                ;PTANL REQUIRES SUBROUTINES DESIGN, DPACC, CARVE,
                ;     INOUT, AND THEIR ASSOCIATED SUBROUTINES.
                ;     ALSO REQUIRES ACCESS TO MANY GLOBAL
                ;     NAMES IN PTEXP


                ;       G.M. OLSON
                ;       19 MARCH 1973 (A)


                        .TITL PTANL
                        .ENT PSYCH
                        .EXTD EXP,SUBJ,ATYPE,ARE,TRLS
                        .EXTD REPC,AFP,NFP,CT,ACS,ETXT
                        .EXTD ABNDC,QUACC,CLEVE,ITYP,OVINC
                        .EXTD ATIME,ACODE,ISTIM,IFORE


                        .ZREL
00000-000000'  PSYCH:   WHY     ;ENTRY POINT
00001-000514'  PTXT:    TXT1    ;ZERO PAGE TEXT ADDRESSES
00002-000542'           TXT2
00003-000553'           TXT3
00004-000600'           TXT4
00005-000612'  ITXT:    TXT5
00006-000635'           TXT6
00007-000707'           TXT7
00010-000765'           TXT8
00011-001045'           TXT9
00012-001135'           TXT10
00013-001137'           TXT11
00014-001141'           TXT12
00015-001142'           TXT13
00016-000475'  ANIND:   NIND
00017-000474'  ASIZE:   SIZE
00020-000000   ARET:    0
00021-000407'  AITAB:   ITAB
00022-000440'  ASOPT:   SOPT
```

```
00023-000473' ASTAPT: START

                      .NPEL
00000'054520  WHY:    STA 3,WORK        ;STORE RETURN
00001'020001-         LDA 0,PTXT        ;PRINT HEADINGS
00002'006003$         JSR @ATYPE
00003'024001$         LDA 1,EXP
00004'006014$         JSR @ABNDC
00005'020002-         LDA 0,PTXT+1
00006'006003$         JSR @ATYPE
00007'024002$         LDA 1,SUBJ
00010'006014$         JSR @ABNDC
00011'020006$         LDA 0,REPC
00012'040511          STA 0,WORK+3
00013'014510          DSZ WORK+3
00014'000405          JMP .+5
00015'020015-         LDA 0,ITXT+10
00016'006003$         JSR @ATYPE
00017'024020$         LDA 1,OVINC
00020'006014$         JSR @ABNDC
00021'020003-         LDA 0,PTXT+2      ;QUERY FOR ANALYSIS
00022'006004$         JSR @APE          ;BY BLOCKS
00023'044516          STA 1,BLKF
00024'020531          LDA 0,ONE
00025'106414          SUB #0,1,SZR
00026'000404          JMP EASY          ;NO BLOCK ANALYSIS
00027'020004-         LDA 0,PTXT+3      ;
00030'006004$         JSR @APE          ;GET BLOCKSIZE FOR
00031'044511          STA 1,BLKSZ       ;ANALYSIS
00032'020013$ EASY:   LDA 0,BTXT
00033'006004$         JSR @APE
00034'044017$         STA 1,ITYP
00035'022506          LDA 0,@ARRAS      ;SET UP ARRAY
00036'040511          STA 0,ENTER       ;ADDRESSES FOR
00037'022505          LDA 0,@ARRAS+1    ;OVERALL ANALYSIS
00040'040510          STA 0,ENTER+1
00041'022504          LDA 0,@ARRAS+2
00042'040507          STA 0,ENTER+2
00043'022503          LDA 0,@ARRAS+3
00044'040506          STA 0,ENTER+3
00045'020005$         LDA 0,TRLS
00046'042017-         STA 0,@ASIZE
00047'004516          JSR GAP           ;DO OVERALL ANALYSIS
00050'020471          LDA 0,BLKF        ;CHECK IF ANALYSIS
00051'024504          LDA 1,ONE         ;IS TO BE DONE BY
00052'106414          SUB #0,1,SZR      ;BLOCKS
00053'002445          JMP @WORK         ;NO-- RETURN
00054'020464          LDA 0,ZERO
00055'040457          STA 0,WORK+14
00056'020005$         LDA 0,TRLS        ;SET UP TRIAL COUNT
00057'040453          STA 0,WORK+12
00060'020462          LDA 0,BLKSZ       ;LOAD BLOCK SIZE
00061'042017-         STA 0,@ASIZE      ;INTO CALL TO DPACC
00062'040451          STA 0,WORK+13
00063'020475  NUB:    LDA 0,FOUR        ;SET UP TEMPORARY
00064'040445          STA 0,WORK+11     ;ADDRESS LOADING COUNTER
00065'034466          LDA 3,IARRS       ;SET UP POINTERS FOR
00066'030466          LDA 2,IENT        ;PICKING OUT DATA BY BLOCKS
00067'024005$ NUNC:   LDA 1,TRLS        ;
00070'023400          LDA @0,0,3        ;GET ADDRESS
```

```
00071'107000            ADD 0,1          ;INCREMENT BY TRIAL COUNT
00072'020441            LDA 0,WORK+13
00073'106400            SUB 0,1          ;DECREMENT BY BLOCK COUNT
00074'045000            STA 1,0,2        ;STORE IN ENTER
00075'151400            INC 2,2          ;SET FOR NEXT
00076'175400            INC 3,3          ;ADDRESSES
00077'014432            DSZ WORK+11      ;CHECK IF DONE
00100'000767            JMP NINC         ;LOOP
00101'020005-           LDA 0,ITXT       ;PRINT BLOCK HEADING
00102'006003$           JSR @ATYPE
00103'010431            ISZ WORK+14      ;CHANGE BLOCK NUMBER
00104'024430            LDA 1,WORK+14
00105'006014$           JSR @ABNDC       ;PRINT BLOCK NUMBER
00106'004457            JSR GAR          ;DO ANALYSIS
00107'020423            LDA 0,WORK+12    ;
00110'024423            LDA 1,WORK+13    ;CHECK IF DONE
00111'122405            SUB 1,0,SNR
00112'002406            JMP @WORK        ;EXIT
00113'020420            LDA 0,WORK+13    ;INCR BLOCK COUNTER
00114'024426            LDA 1,BLKSZ      ;BY BLOCK SIZE
00115'107000            ADD 0,1
00116'044415            STA 1,WORK+13
00117'000744            JMP NUB          ;LOOP
      000020  WORK:     .BLK 20
00140'000000  ZERO:     0
00141'000000  BLKF:     0
00142'000000  BLKSZ:    0
00143'000021$ ARRAS:    ATIME
00144'000022$           ACODE
00145'000023$           ISTIM
00146'000024$           IFORE
00147'000000  ENTER:    0
00150'000000            0
00151'000000            0
00152'000000            0
00153'000143' IARRS:    ARRAS
00154'000147' IENT:     ENTER
00155'000001  ONE:      1
00156'000002  TWO:      2
00157'000003  THREE:    3
00160'000004  FOUR:     4
00161'000401' AT1:      WTABC
00162'000374' AT2:      MTABI
00163'000404' AT3:      WTABI
00164'000410' AT4:      ITAB+1

              ;ROUTINE FOR ORGANIZING ANALYSIS

00165'054020- GAR:      STA 3,ARET       ;SAVE RETURN
00166'020752            LDA 0,ZERO       ;SET UP FOR
00167'042016-           STA 0,@ANIND     ;OVERALL ANALYSIS
00170'020757            LDA 0,ENTER
00171'042023-           STA 0,@ASTART
00172'020763            LDA 0,ONE
00173'042766            STA 0,@AT1
00174'020762            LDA 0,TWO
00175'042765            STA 0,@AT2
00176'042765            STA 0,@AT3
00177'020006-           LDA 0,ITXT+1
00200'006003$           JSR @ATYPE
```

```
00201'020747            LDA 0,ENTEP+1
00202'042021-           STA 0,@AITAB
00203'006022-           JSR @ASORT          ;DO ANALYSIS
00204'020011$           LDA 0,CT            ;CHECK NUMBER OF
00205'040717            STA 0,WORK+4        ;STIMULI
00206'014716            DSZ WORK+4          ; =1?
00207'000402            JMP .+2             ;NO
00210'000434            JMP FPTST           ;YES - SKIP TO FP
00211'020007-           LDA 0,ITXT+2
00212'006003$           JSR @ATYPE
00213'020736            LDA 0,ENTEP+2
00214'042021-           STA 0,@AITAB
00215'020733            LDA 0,ENTER+1
00216'042746            STA 0,@AT4
00217'020547            LDA 0,MSK7          ;SET VARIABLE MASKS AND WORDS
00220'040554            STA 0,MTABI
00221'020735            LDA 0,TWO
00222'040553            STA 0,MTABI+1
00223'040562            STA 0,WTABI+1
00224'020731            LDA 0,ONE
00225'040555            STA 0,WTABC+1
00226'010676            ISZ WORK+4
00227'020726  RSTIM:    LDA 0,ONE           ;RESET INDICATOR COUNT
00230'042016-           STA 0,@ANIND
00231'030012$           LDA 2,ACS           ;LOAD ADDR OF STIM TABLE
00232'020672            LDA 0,WORK+4        ;LOAD CURRENT COUNT
00233'113000            ADD 0,2             ;ADD TO CREATE ADDR OF STIM
00234'025000            LDA 1,0,2           ;(AC1)=CURRENT STIM
00235'044542            STA 1,WTAB0         ;STORE IN WORD TABLES
00236'044543            STA 1,WTABC
00237'044545            STA 1,WTABI
00240'006014$           JSR @ABNDC          ;PRINT STIM NO.

00241'006022-           JSR @ASORT          ;DO ANALYSIS
00242'014662            DSZ WORK+4          ;CHECK IF DONE
00243'000764            JMP RSTIM           ;LOOP
00244'020010$ FPTST:    LDA 0,NFP           ;CHECK NO OF FPS
00245'040660            STA 0,WORK+5
00246'014657            DSZ WORK+5
00247'000402            JMP .+2
00250'002020-           JMP @ARET
00251'020010-           LDA 0,ITXT+3
00252'006003$           JSR @ATYPE
00253'020677            LDA 0,ENTER+3
00254'040533            STA 0,ITAB
00255'020673            LDA 0,ENTER+1
00256'040532            STA 0,ITAB+1
00257'020507            LDA 0,MSK7
00260'040514            STA 0,MTABI
00261'020675            LDA 0,TWO
00262'040513            STA 0,MTABI+1
00263'040522            STA 0,WTABI+1
00264'020671            LDA 0,ONE
00265'040515            STA 0,WTABC+1
00266'010637            ISZ WORK+5
00267'020666  PFORE:    LDA 0,ONE
00270'042016-           STA 0,@ANIND
00271'030007$           LDA 2,AFP           ;LOAD ADDR OF FP TABLE
00272'020633            LDA 0,WORK+5        ;LOAD CURRENT BLOCK COUNT
00273'113000            ADD 0,2             ;CREATE ADDR OF NEXT FP
```

```
00274'025000            LDA 1,0,2       ;LOAD NEXT FP
00275'044502            STA 1,WTAB0     ;STORE IN WORD TABLES
00276'044503            STA 1,WTABC
00277'044505            STA 1,WTABI
00300'006014$           JSR @ABNDC      ;PRINT CURRENT FP
00301'006022-           JSR @ASORT      ;DO ANALYSIS
00302'014623            DSZ WORK+5      ;CHECK IF DONE
00303'000764            JMP BFORE
00304'020011$ BOTH:     LDA 0,CT        ;CHECK FOR NUMBER
00305'040513            STA 0,TEMP+6    ;OF STIM
00306'014512            DSZ TEMP+6
00307'000402            JMP .+2
00310'002020-           JMP @ARET
00311'020011-           LDA 0,ITXT+4
00312'006003$           JSR @ATYPE
00313'020636            LDA 0,ENTER+2
00314'040473            STA 0,ITAB
00315'020635            LDA 0,ENTER+3
00316'040472            STA 0,ITAB+1
00317'020631            LDA 0,ENTER+1
00320'040471            STA 0,ITAB+2
00321'020445            LDA 0,MSK7
00322'040452            STA 0,MTABI
00323'040452            STA 0,MTABI+1
00324'020631            LDA 0,ONE       ;SET UP FOR STIM & FP
00325'040456            STA 0,WTABC+2   ;ANALYSIS
00326'020630            LDA 0,TWO
00327'040447            STA 0,MTABI+2
00330'040456            STA 0,WTABI+2
00331'010467            ISZ TEMP+6
00332'030012$ SAIL:     LDA 2,ACS       ;OUTER LOOP - STIM
00333'020465            LDA 0,TEMP+6
00334'113000            ADD 0,2
00335'025000            LDA 1,0,2
00336'044441            STA 1,WTAB0
00337'044442            STA 1,WTABC
00340'044444            STA 1,WTABI
00341'020010$           LDA 0,NFP       ;RESET FP COUNT
00342'040450            STA 0,TEMP
00343'020613  FLY:      LDA 0,TWO
00344'042016-           STA 0,@ANIND
00345'030007$           LDA 2,AFP       ;INNER LOOP - FPS
00346'020444            LDA 0,TEMP
00347'113000            ADD 0,2
00350'025000            LDA 1,0,2
00351'044427            STA 1,WTAB0+1
00352'044430            STA 1,WTABC+1
00353'044432            STA 1,WTABI+1
00354'024423            LDA 1,WTAB0
00355'006014$           JSR @ABNDC
00356'024422            LDA 1,WTAB0+1
00357'006014$           JSR @ABNDC
00360'006022-           JSR @ASORT      ;DO ANALYSIS
00361'014431            DSZ TEMP        ;CHECK FP COUNT
00362'000761            JMP FLY
00363'014435            DSZ TEMP+6      ;CHECK STIM COUNT
00364'000746            JMP SAIL
00365'002020-           JMP @ARET       ;EXIT
00366'177777  MSK7:     177777
00367'177777  MTAB0:    177777
```

```
00370'177777                177777
00371'177777  MTABC:       177777
00372'177777                177777
00373'177777                177777
      000003  MTABI:       .BLK 3
      000002  WTABO:       .BLK 2
      000003  WTABC:       .BLK 3
      000003  WTABI:       .BLK 3
      000003  ITAB:        .BLK 3
      000020  TEMP:        .BLK 20
00432'000366' AMTAB:       MTABO-1
00433'000370'              MTABC-1
00434'000373'              MTABI-1
00435'000376' AWTAB:       WTABO-1
00436'000400'              WTABC-1
00437'000403'              WTABI-1

                ;ROUTINE FOR ORGANIZING EACH ANALYSIS
                ;INTO OVERALL, CORRECT, INCORRECT

00440'054754  SORT:        STA 3,TEMP+2      ;SAVE RETURN
00441'024771               LDA 1,AMTAB       ;MASK TABLE ADDR
00442'030773               LDA 2,AWTAB       ;WORD TABLE ADDR
00443'004422               JSR MEAN          ;DO ANALYSIS
00444'020006$              LDA 0,PEPC        ;CHECK IF ANY ERRORS
00445'040746               STA 0,TEMP+1      ;POSSIBLE IN DESIGN
00446'014745               DSZ TEMP+1
00447'000404               JMP .+4
00450'020013-              LDA 0,ITXT+6
00451'006003$              JSR @ATYPE        ;CR + LF
00452'002742               JMP @TEMP+2       ;EXIT - NO ERRORS
00453'010422               ISZ NIND          ;BUMP INDICATOR COUNT
                                             ;SET FOR CORRECT
00454'024757               LDA 1,AMTAB+1     ;RESP ANALYSIS
00455'030761               LDA 2,AWTAB+1
00456'004407               JSR MEAN          ;DO ANALYSIS
                                             ;SET FOR ERROR
00457'024755               LDA 1,AMTAB+2     ;ANALYSIS
00460'030757               LDA 2,AWTAB+2
00461'004404               JSR MEAN          ;DO ERROR ANALYSIS
00462'020013-              LDA 0,ITXT+6
00463'006003$              JSR @ATYPE        ;CR + LF
00464'002730               JMP @TEMP+2       ;EXIT

                ;ROUTINE TO CALL DPACC AND CARVE

00465'044412  MEAN:        STA 1,AMASK       ;MASK TABLE ADDR
00466'050412               STA 2,AWORD       ;WORD TABLE ADDR
00467'054726               STA 3,TEMP+3      ;RETURN
00470'006015$              JSR @QUACC        ;GO TO ACCUM ROUTINE
00471'000504'              TOTAL             ;ADDR OF D.P. SUM
00472'000506'              COUNT             ;ADDR OF DATA COUNT
00473'000000  START:       0                 ;START OF DATA ARRAY
00474'000000  SIZE:        0                 ;SIZE OF ARRAYS
00475'000000  NIND:        0                 ;NUMBER OF INDICATORS
00476'000406'              ITAB-1            ;ADDR OF IND. ADDRESSES
00477'000000  AMASK:       0                 ;ADDR OF MASKS
00500'000000  AWORD:       0                 ;ADDR OF WORDS
00501'020012-              LDA 0,ITXT+5
00502'006003$              JSR @ATYPE
```

```
00503'006016$           JSR @CLEVE      ;DO DIVISION
00504'000000  TOTAL:    0
00505'000000            0
00506'000000  COUNT:    0
00507'020014-           LDA 0,ITXT+7
00510'006003$           JSR @ATYPE      ;SINGLE SPACE
00511'024775            LDA 1,COUNT
00512'006014$           JSR @ABNDC      ;PRINT DATA COUNT
00513'002702            JMP @TEMP+3     ;EXIT

00514'006440  TXT1: .TXT * <15>
00515'005012  <12><12>
00516'005012  <12><12>
00517'042040   D
00520'052101  AT
00521'020101  A
00522'047101  AN
00523'046101  AL
00524'051531  YS
00525'051511  IS
00526'043040   F
00527'051117  OR
00530'051040   P
00531'020124  T
00532'054105  EX
00533'042520  PE
00534'044522  RI
00535'042515  ME
00536'052116  NT
00537'047040   N
00540'027117  O.
00541'000040   *
00542'006440  TXT2: .TXT * <15>
00543'020012  <12>
00544'052523  SU
00545'045102  BJ
00546'041505  EC
00547'020124  T
00550'047516  NO
00551'020056  ..
00552'000000  *
00553'006440  TXT3: .TXT * <15>
00554'005012  <12><12>
00555'040440   A
00556'040516  NA
00557'054514  LY
00560'044523  SI
00561'020123  S
00562'054502  BY
00563'041040   B
00564'047514  LO
00565'045503  CK
00566'037523  S?
00567'024040   (
00570'024461  1)
00571'054440   Y
00572'051505  ES
00573'024040   (
00574'024462  2)
00575'047040   N
```

```
00576'020117  0
00577'000000  *
00600'006440  TXT4:  .TXT .* <15>
00601'020012  <12>
00602'046102  BL
00603'041517  OC
00604'020113  K
00605'044523  SI
00606'042532  ZE
00607'036440   =
00610'037440   ?
00611'000040   *
00612'006440  TXT5:  .TXT * <15>
00613'005012  <12><12>
00614'040440   A
00615'040516  NA
00616'054514  LY
00617'044523  SI
00620'020123  S
00621'054502  BY
00622'041040   B
00623'047514  LO
00624'045503  CK
00625'020123  S
00626'005015  <15><12>
00627'041040   B
00630'047514  LO
00631'045503  CK
00632'047040   N
00633'027117  O.
00634'000040   *
00635'005015  TXT6:    .TXT *<15><12>
00636'005012  <12><12>
00637'053117  OV
00640'051105  ER
00641'046101  AL
00642'020114  L
00643'047101  AN
00644'046101  AL
00645'051531  YS
00646'051511  IS
00647'005015  <15><12>
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00651'020040
00652'053117  OV
00653'051105  ER
00654'046101  AL
00655'020114  L
00656'052122  RT
00657'020040
00660'020040
00661'047040   N
00662'020040
00663'041440   C
00664'051117  OR
00665'042522  RE
00666'052103  CT
00667'051040   R
00670'020124  T
00671'020040
```

```
00672'020040
00673'020116  N
00674'020040
00675'020040
00676'051105  ER
00677'047522  RO
00700'020122  R
00701'052122  RT
00702'020040
00703'020040
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00707'005015  TXT7:    .TXT *<15><12>
00710'005012  <12><12>
00711'047101  AN
00712'046101  AL
00713'051531  YS
00714'051511  IS
00715'041040   B
00716'020131  Y
00717'052123  ST
00720'046511  IM
00721'046125  UL
00722'006511  I<15>
00723'005012  <12><12>
00724'051440   S
00725'044524  TI
00726'020115  M
00727'020040
00730'053117  OV
00731'051105  ER
00732'046101  AL
00733'020114  L
00734'052122  RT
00735'020040
00736'020040
00737'047040   N
00740'020040
00741'041440   C
00742'051117  OR
00743'042522  PE
00744'052103  CT
00745'051040   R
00746'020124  T
00747'020040
00750'020040
00751'020116  N
00752'020040
00753'020040
00754'051105  ER
00755'047522  RO
00756'020122  R
00757'052122  RT
00760'020040
00761'020040
00762'047040   N
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00764'000012  <12>*
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00770'046101  AL
00771'051531  YS
00772'051511  IS
00773'041040   B
00774'020131  Y
00775'047506  FO
00776'042522  RE
00777'042520  PE
01000'044522  RI
01001'042117  OD
01002'006523  S<15>
01003'005012  <12><12>
01004'020040
01005'043040   F
01006'020120  P
01007'020040
01010'053117  OV
01011'051105  ER
01012'046101  AL
01013'020114  L
01014'052122  RT
01015'020040
01016'020040
01017'047040   N
01020'020040
01021'041440   C
01022'051117  OR
01023'042522  RE
01024'052103  CT
01025'051040   R
01026'020124  T
01027'020040
01030'020040
01031'020116  N
01032'020040
01033'020040
01034'051105  ER
01035'047522  RO
01036'020122  R
01037'052122  RT
01040'020040
01041'020040
01042'047040   N
01043'005015  <15><12>
01044'000012  <12>*
01045'005015  TXT9:    .TXT *<15><12>
01046'005012  <12><12>
01047'047101  AN
01050'046101  AL
01051'051531  YS
01052'051511  IS
01053'041040   B
01054'020131  Y
01055'052123  ST
01056'046511  IM
01057'046125  UL
01060'020111  I
01061'020130  X
```

```
01062'047506  FO
01063'042522  RE
01064'042520  PE
01065'044522  RI
01066'042117  OD
01067'006523  S<15>
01070'005012  <12><12>
01071'051440   S
01072'044524  TI
01073'020115  M
01074'020040
01075'050106  FP
01076'020040
01077'047440   O
01100'042526  VE
01101'040522  RA
01102'046114  LL
01103'051040   R
01104'020124  T
01105'020040
01106'020040
01107'020116  N
01110'020040
01111'047503  CO
01112'051122  RR
01113'041505  EC
01114'020124  T
01115'052122  RT
01116'020040
01117'020040
01120'047040   N
01121'020040
01122'020040
01123'042440   E
01124'051122  RR
01125'051117  OR
01126'051040   R
01127'020124  T
01130'020040
01131'020040
01132'006516  N<15>
01133'005012  <12><12>
01134'000000  *
01135'020040  TXT10:   .TXT *
01136'000040   *
01137'005015  TXT11:   .TXT *<15><12>
01140'000000  *
01141'000040  TXT12:   .TXT * *
01142'005015  TXT13:   .TXT *<15><12>
01143'052040  'T
01144'052117  OT
01145'046101  AL
01146'042440   E
01147'051122  RR
01150'051117  OR
01151'020123  S
01152'042522  RE
01153'052522  RU
01154'020116  N
01155'020075  =
01156'000040   *
```

```
                ;  SUBROUTINE CARVE -- ROUTINE TO DIVIDE A
                ;DOUBLE PRECISION FIXED POINT NUMBER BY
                ;A SINGLE PRECISION FIXED POINT NUMBER,
                ;YIELDING AND PRINTING OUT A FLOATING
                ;POINT NUMBER IN ORDINARY DECIMAL
                ;NOTATION
                ;***NOTE:  CARVE DOES NOT SAVE THE
                ;QUOTIENT, ONLY PRINTS IT OUT
                ;
                ;CALL TO CARVE IS:
                ;       JSR @CLEVE
                ;       HIGH ORDER DIVIDEND
                ;       LOW ORDER DIVIDEND
                ;       DIVISOR
                ;       RETURN
                ;
                ;>>>>>USES SUBROUTINES PROQ & INOUT
                ;
                ;PORTIONS OF THIS ROUTINE ARE
                ;BASED ON THE ROUTINE BNDEC
                ;FOUND IN THE PUBLICATION,
                ;"HOW TO USE THE NOVA COMPUTERS"
                ;COPYRIGHT 1971, DATA GENERAL CORPORATION
                ;REPRODUCED BY PERMISSION
                ;
                ;       G.M.OLSON
                ;       19 MARCH 1973 (A)

                        .TITL CARVE
                        .ENT CLEVE
                        .EXTD APUTC,ALGAE,MONK

                        .ZREL
00000-000000'   CLEVE:  CUT

                        .NREL
00000'020444    CUT:    LDA 0,THREE     ;SAVE (AC3) + 3
00001'163000            ADD 3,0         ;FOR RETURN
00002'040450            STA 0,SPLIT
00003'021400            LDA 0,0,3       ;GET HIGH ORDER DVD.
00004'025401            LDA 1,1,3       ;GET LOW ORDER DVD.
00005'031402            LDA 2,2,3       ;GET DIVISOR
00006'050431            STA 2,DIVSR     ;STORE "
00007'006002$           JSR @ALGAE      ;DIVIDE
00010'040424            STA 0,REND      ;STORE REMAINDER
00011'020431            LDA 0,ZERO      ;SET INDICATOR TO PRINT
00012'040423            STA 0,BLUR      ;LEADING BLANKS
00013'121000            MOV 1,0
00014'004445            JSR SLICE       ;PRINT INTEGRAL PART
00015'020433            LDA 0,PUNCT
00016'006001$           JSR @APUTC      ;PRINT DECIMAL POINT
00017'020426            LDA 0,FOUR      ;SET COUNTER TO 4
00020'040421            STA 0,SHARP
00021'024413    POINT:  LDA 1,REND      ;GET REMAINDER
00022'030522            LDA 2,TENS+3    ;GET CONSTANT 10
00023'006003$           JSR @MONK       ;MULTIPLY
00024'030413            LDA 2,DIVSR     ;GET DIVISOR
00025'006002$           JSR @ALGAE      ;DIVIDE AGAIN
00026'040406            STA 0,REND      ;SAVE REMAINDER
```

```
00027'121000            MOV 1,0
00030'004431            JSR SLICE       ;PRINT NEXT DECIMAL PART
00031'014410            DSZ SHARP       ;DECREMENT COUNTER
00032'000767            JMP POINT       ;REPEAT
00033'002417            JMP @SPLIT      ;SPLIT TO CALLING ROUTINE

00034'000000  REND:     0
00035'000000  BLUR:     0
00036'000000  DICE:     0
00037'000000  DIVSP:    0
00040'000000  LAST:     0
00041'000000  SHARP:    0
00042'000000  ZERO:     0
00043'000001  ONE:      1
00044'000003  THREE:    3
00045'000004  FOUR:     4
00046'000005  FIVE:     5
00047'000060  C60:      60
00050'000056  PUNCT:    56
00051'000040  BLANK:    40
      000007  SPLIT:    .BLK 7

              ;ROUTINE TO PRINT DECIMAL NUMBERS
              ;WITHOUT LEADING ZEROES (BASED ON
              ;BNDEC), RIGHT JUSTIFIED

00061'054772  SLICE:    STA 3,SPLIT+1
00062'034760            LDA 3,ZERO      ;SET INDICATOP TO
00063'054753            STA 3,DICE      ;SUPPRESS LEADING ZEROES
00064'034762            LDA 3,FIVE      ;SET PLACE COUNT
00065'054753            STA 3,LAST
00066'034460            LDA 3,INST
00067'054401            STA 3,.+1
00070'000000  MINCE:    0
00071'020756            LDA 0,C60
00072'146443            SUBO 2,1,SNC
00073'101401            INC 0,0,SKP
00074'147001            ADD 2,1,SKP
00075'000775            JMP .-3
00076'050757            STA 2,SPLIT+3   ;SAVE (AC2)
00077'014741            DSZ LAST        ;DECREMENT PLACE COUNT
00100'000402            JMP .+2
00101'000424            JMP SPOIL
00102'034734            LDA 3,DICE      ;GET INDICATOR
00103'030737            LDA 2,ZERO      ;AND ZERO, CHECK
00104'156414            SUB# 2,3,SZR    ;IF EQUAL
00105'000420            JMP SPOIL       ;NOT EQUAL -- PRINT CHAR.
00106'030735            LDA 2,ONE
00107'034740            LDA 3,C60
00110'116414            SUB# 0,3,SZR    ;CURRENT DIGIT 0?
00111'000413            JMP SPOIL-1     ;NO, CHANGE INDICATOR
00112'034723            LDA 3,BLUR
00113'030727            LDA 2,ZERO
00114'156414            SUB# 2,3,SZR
00115'000405            JMP POKE        ;DO NOT PRINT LEADING ZEROES
00116'040737            STA 0,SPLIT+3
00117'020732            LDA 0,BLANK
00120'006001$           JSR @APUTC      ;PRINT LEADING BLANK
00121'020734            LDA 0,SPLIT+3   ;RESTORE (AC0)
00122'030732  POKE:     LDA 2,SPLIT+2   ;RESTORE (AC2)
```

```
00123'000410            JMP PARE
00124'050712            STA 2,DICE
00125'006001$ SPOIL:    JSR @APUTC          ;PRINT CHARACTER
00126'030712            LDA 2,LAST          ;CHECK IF LAST
00127'034713            LDA 3,ZERO          ;CHARACTER
00130'156415            SUB# 2,3,SNR
00131'000405            JMP PARE+3
00132'030722            LDA 2,SPLIT+2
00133'010735  PARE:     ISZ MINCE           ;BACK INTO BNDEC
00134'151203            MOVR 2,2,SNC
00135'000733            JMP MINCE
00136'020705            LDA 0,ONE
00137'040676            STA 0,BLUR
00140'002713            JMP @SPLIT+1

      000012            .RDX 10
00141'023420  TENS:     10000
00142'001750            1000
00143'000144            100
00144'000012            10
00145'000001            1

      000010            .RDX 8
00146'030451  INST:     LDA 2,.+TENS-MINCE
                        .END
```

```
                        ;UNSIGNED DIVIDE, MULTIPLY
                        ;
                        ;COPYRIGHT 1969, DATA GENERAL CORPORATION
                        ;REPRODUCED BY PERMISSION.
                        ;       ADAPTED FROM DATA GENERAL
                        ;       MATH ROUTINE PACKAGE BY
                        ;               G.M. OLSON
                        ;               20 NOVEMBER 1972 (B)

                        .TITL RPOQ
                        .ENT MONK,AMOEB,NIN,ALGAE

                        .ZREL
00000-000021' MONK:     .MPYU
00001-000022' NIN:      .MPYA
00002-000001' ALGAE:    .DIVU
00003-000000' AMOEB:    .DIVI

                        .NREL


00000'102400  .DIVI:    SUB 0,0         ; INTEGER DIVIDE, CLEAR AC0
00001'054416  .DIVU:    STA 3,.CC03     ; SAVE AC3
00002'142432            SUBZ# 2,0,SZC   ; TEST FOR OVERFLOW
00003'000412            JMP .CC99       ; SET CARRY AND RETURN
00004'034414            LDA 3,.CC20     ; 16 ITERATIONS
00005'125120            MOVZL 1,1       ; SHIFT LOW DIVIDEND
00006'101100  .CC98:    MOVL 0,0        ; SHIFT HIGH DIVIDEND
00007'142412            SUB# 2,0,SZC    ; DOES DIVISOR GO IN?
00010'142400            SUB 2,0         ; YES
00011'125100            MOVL 1,1        ; SHIFT LOW DIVIDEND
00012'175404            INC 3,3,SZR     ; CHECK COUNT
00013'000773            JMP .CC98       ; NOT DONE
00014'176441            SUBO 3,3,SKP    ; DONE , CLEAR CARRY
00015'176420  .CC99:    SUBZ 3,3        ; SET CARRY
00016'002401            JMP @.CC03      ; RETURN


00017'000000  .CC03:    0               ; SAVE AC3

00020'177760  .CC20:    -20             ; - 16 DECIMAL


00021'102460  .MPYU:    SUBC 0,0        ; CLEAR AC0, DON'T DISTURB
                                        ; CARRY
00022'054411  .MPYA:    STA 3,.CB03     ; SAVE AC3
00023'034411            LDA 3,.CB20     ; 16 TIMES THRU LOOP
00024'125203  .CB99:    MOVR 1,1,SNC    ; CHECK NEXT MULTIPLIER BIT
00025'101201            MOVR 0,0,SKP    ; 0, JUST SHIFT
00026'143220            ADDZR 2,0       ; 1, ADD MULTIPLICAND AND SHIFT
00027'175404            INC 3,3,SZR     ; CHECK FOR 16TH TIME THRU
00030'000774            JMP .CB99       ; NO, CONTINUE
00031'125260            MOVCR 1,1       ; YES, SHIFT LAST LOW BIT
                                        ; (NOTE IT WAS COMPLEMENTED BY
                                        ; FINAL INC)
00032'002401            JMP @.CB03      ; RETURN

00033'000000  .CB03:    0               ; RETURN ADDRESS
00034'177760  .CB20:    -20             ; -16 DECIMAL
```

```
                ;    SUBROUTINE DPACC -- ACCUMULATES THE SUM
                ;OF A SERIES OF ARBITRARY SINGLE PRECISION
                ;VALUES IN A DOUBLE PRECISION ACCUMULATOR.
                ;ALLOWS OPTIONAL INCORPORATION OF SELECTIVE
                ;ACCUMULATION OUT OF THE USER'S DATA ARRAY
                ;BY MEANS OF A SET OF INDICATOR ARRAYS THAT
                ;PARALLEL THE STRUCTURE OF THE DATA ARRAY.
                ;BOTH A MASK AND A TEST WORD ARE USED
                ;TO SELECT DATA ON THE BASIS OF A GIVEN
                ;INDICATOR ARRAY, AND WHEN MORE THAN ONE
                ;INDICATOR IS USED THE SELECTION IS BASED
                ;ON ALL INDICATORS SIMULTANEOUSLY, I.E.,
                ;THE INDIVIDUAL YES-NO DECISIONS ARE ANDED,
                ;SO THAT A DATUM MUST PASS ALL TESTS BEFORE
                ;IT WILL BE ACCUMULATED.
                ;    THE CALLING SEQUENCE IS:
                ;        JSR @QUACC
                ;        ADDRESS OF HIGH ORDER WORD FOR D.P.
                ;                SUM (FOR OUTPUT)
                ;        ADDRESS OF DATA COUNT (FOR OUTPUT)
                ;        ADDRESS-1 OF DATA ARRAY
                ;        SIZE OF DATA ARRAY
                ;        NUMBER OF INDICATOR ARRAYS
                ;        ADDRESS-1 OF ADDRESS-1S OF INDICATOR
                ;                ARRAYS
                ;        ADDRESS-1 OF TABLE OF INDICATOR MASKS
                ;        ADDRESS-1 OF TABLE OF INDICATOR WORDS
                ;        RETURN
                ;
                ;   NOTE:  IF NUMBER OF INDICATOR ARRAYS IS
                ;ZERO, ENTIRE DATA ARRAY IS ACCUMULATED.
                ;RELEVANT ARGUMENTS IN THE SUBROUTINE CALL MUST
                ;BE FILLED WITH DUMMY VALUES.  THIS
                ;ROUTINE ALWAYS SETS THE D.P. SUM TO
                ;ZERO ON ENTRY.
                ;
                ;        G.M. OLSON
                ;        5 DECEMBER 1972 (A)
                ;

                        .TITL DPACC
                        .ENT QUACC

                        .ZREL
00000-000000' QUACC:    FORTH
00001-000125' FLASH:    .DADD

                        .NREL
00000'030507  FORTH:    LDA 2,EIGHT     ;SET RETURN AT
00001'173000            ADD 3,2         ;(AC3) + 8
00002'050500            STA 2,BACK
00003'031400            LDA 2,0,3       ;STORE ADDR. OF
00004'050464            STA 2,ASUM      ;D.P.SUM
00005'024500            LDA 1,ZERO      ;ZERO D.P. SUM
00006'045000            STA 1,0,2
00007'045001            STA 1,1,2
00010'044506            STA 1,WORK      ;ZERO COUNTER
00011'044477            STA 1,TEMCT     ;ZERO DATA COUNT
00012'021401            LDA 0,1,3       ;STORE ADDR. OF
00013'040476            STA 0,ACT       ;DATA COUNT
```

```
00014'021402            LDA 0,2,3       ;STORE ADDR.-1
00015'040020            STA 0,20        ;OF DATA ARRAY
00016'021403            LDA 0,3,3       ;STORE SIZE OF
00017'040464            STA 0,SIZE      ;DATA ARRAY
00020'021404            LDA 0,4,3       ;STORE NUMBER OF
00021'040471            STA 0,GNAPR     ;INDICATOR ARRAYS
00022'021405            LDA 0,5,3       ;STORE LOC. OF
00023'040470            STA 0,ARTAB     ;TABLE OF IND. ADDR.
00024'021406            LDA 0,6,3       ;STORE LOC. OF
00025'040467            STA 0,AMTAB     ;MASK TABLE
00026'021407            LDA 0,7,3       ;STORE LOC. OF
00027'040466            STA 0,AWTAB     ;WORD TABLE

00030'010466  NACC:     ISZ WORK        ;INCR. COUNTER
00031'020454            LDA 0,ZERO      ;SET SKIP IND. TO 0
00032'040452            STA 0,IND
00033'024457            LDA 1,GNAPR     ;GET NO. OF IND. ARRAYS
00034'106415            SUB# 0,1,SNR    ;= 0?
00035'000424            JMP ACCUM       ;JUMP TO ACCUM
00036'044461            STA 1,WORK+1    ;STORE NO. IND.
00037'020454            LDA 0,ARTAB     ;TRANSFER ADDR. OF
00040'040021            STA 0,21        ;PARAMETERS TO
00041'020453            LDA 0,AMTAB     ;AUTO INC. LOCS
00042'040022            STA 0,22
00043'020452            LDA 0,AWTAB
00044'040023            STA 0,23
00045'022021  OUFIE:    LDA 0,@21       ;GET NEXT IND. ADDR.
00046'030450            LDA 2,WORK      ;GET CURRENT COUNT
00047'113000            ADD 0,2         ;ADD TO GET IND. VALUE
00050'021000            LDA 0,0,2
00051'026022            LDA 1,@22       ;LOAD IND. MASK
00052'123400            AND 1,0         ;MASK
00053'026023            LDA 1,@23       ;LOAD IND. WORD
00054'030432            LDA 2,ONE
00055'122404            SUB 1,0,SZR     ;IND. = WORD?
00056'050426            STA 2,IND       ;NO - SET ACCUM. SKIP
00057'014440            DSZ WORK+1      ;CHECK IF THROUGH
00060'000765            JMP OUFIE
00061'026020  ACCUM:    LDA 1,@20       ;GET NEXT DATUM
00062'020423            LDA 0,ZERO
00063'014421            DSZ IND         ;CHECK IND. SKIP
00064'000402            JMP .+2
00065'000407            JMP ASUM+4      ;SKIP ACCUM
00066'010422            ISZ TEMCT       ;INC. DATA COUNT
00067'006001-           JSR @FLASH      ;ACCUMULATE
00070'000000  ASUM:     0
00071'030777            LDA 2,ASUM      ;TRANSFER NEW SUM
00072'041000            STA 0,0,2       ;TO STORAGE
00073'045001            STA 1,1,2
00074'014407            DSZ SIZE        ;CHECK IF DONE
00075'000733            JMP NACC
00076'024412            LDA 1,TEMCT     ;TRANSFER DATA COUNT
00077'030412            LDA 2,ACT
00100'045000            STA 1,0,2
00101'002401            JMP @BACK

00102'000000  BACK:     0
00103'000000  SIZE:     0
00104'000000  IND:      0
00105'000000  ZERO:     0
```

```
00106'000001  ONE:    1
00107'000010  EIGHT:  10
00110'000000  TEMCT:  0
00111'000000  ACT:    0
00112'000000  GNARR:  0
00113'000000  ARTAB:  0
00114'000000  AMTAB:  0
00115'000000  AWTAB:  0
      000007  WORK:   .BLK 7

              ;       DATA GENERAL ROUTINE FOR D.P. ADDITION
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00125'054414  .DADD:  STA 3,.BD03     ; SAVE RETURN
00126'010413          ISZ .BD03       ; BUMP PAST ADDRESS CONSTANT
00127'050411          STA 2,.BD02     ; *SAVE AC2
00130'035400          LDA 3,0,3       ; ADDRESS OF D2
00131'031400          LDA 2,0,3       ; HIGH ORDER OF D2
00132'035401          LDA 3,1,3       ; LOW ORDER OF D2
00133'167022          ADDZ 3,1,SZC    ; LOW ORDER ADD
00134'101400          INC 0,0         ; CARRY TO HIGH ORDER
00135'143000          ADD 2,0         ; HIGH ORDER ADD
00136'030402          LDA 2,.BD02     ; *RESTORE AC2
00137'002402          JMP @.BD03      ; AND RETURN


00140'000000  .BD02:  0               ; *SAVE AC2
00141'000000  .BD03:  0               ; SAVE RETURN
                      .END
```

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13. ABSTRACT

RTLAB is a package of relocatable assembly-language subroutines for the design, control, and analysis of behavioral experiments on the Data General Corporation NOVA family of computers. It was originally designed for use in reaction time research but is readily adaptable to any discrete-trial task. RTLAB accepts design parameters from the experimenter for a given experiment and then produces an appropriately randomized and counterbalanced set of trials for presentation to a subject. During an experimental session RTLAB controls the presentation of stimuli, the acceptance and scoring of responses, and all of the timing and input-output constraints associated with control and data acquisition. Its current design does not allow for time-sharing among more than one subject station. A history of the experiment is saved for later analysis and transfer to storage media. User modifications of any of the details of these operations is facilitated by the organization of RTLAB into subroutine modules. The organization of RTLAB and its use are presented along with sufficient documentation of the routines to allow user modification where appropriate.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Data Acquisition Systems						
Minicomputer Applications						
On-line Computers in Psychology						
Reaction-Time						